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Mineral Development Division
Department of Mines and Energy
Government of Newfoundland and Labrador

CURRENT RESEARCH

Report 80 - 1
C. F. O'Driscoll and R. V. Gibbons (Editors)

St. John's, Newfoundland
1980

19

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C. F. O'Driscoll and R. V. Gibbons (Editors)

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PREFACE

This publication continues the series of annual Reports of Activities begun in 1974, in which the Mineral Development Division summarizes work on its projects in progress. The reports contained in this publication have changed over the years, from short statement of activities to fairly lengthy reports on the results of geoscientific studies. This change is reflected this year in a new title - "Current Research."

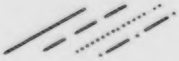
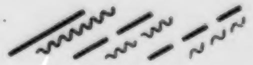
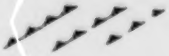
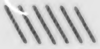
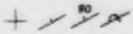
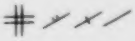
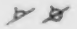
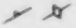
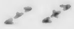
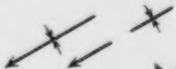
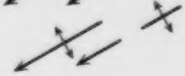
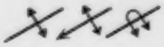
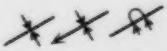
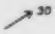
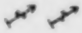
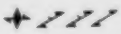
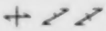
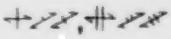
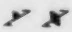
Most of the reports describe work carried out under the Canada-Newfoundland Mineral Development Subsidiary Agreement. This Agreement consists of a five year program (1976-1981) of studies funded by the federal Departments of Energy, Mines & Resources (45%), Regional Economic Expansion (45%) and the Government of Newfoundland & Labrador (10%). Reports 8a & b, 13a & b, 21b and 23 describe work funded entirely by the Province.

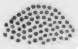
The past year has been a significant one for the Mineral Development Division in a number of areas. It has seen the completion of regional mapping in the major areas of supracrustal sequences in Labrador (the Labrador Trough and the Central Mineral Belt); regional mapping in Labrador will henceforth concentrate on the metamorphic terrains of Grenville and Churchill Provinces. This past year has also seen the initiation of metallogenic studies, aimed at relating mineral occurrences to the geological picture indicated by the mapping programs (Report 9). It is our hope that such studies will continue as a follow-up to the mapping programs in a number of areas.

B.A. Greene
Director
Mineral Development Division
1980 01 10

Any reader who would like to write a rebuttal to, or discussion of, any report contained in this volume is invited to submit it to the editor by November 1, 1980, to be considered for inclusion in Report 81-1.

GEOLOGICAL MAP SYMBOLS

Geological contact (defined, approximate, assumed, gradational)	
Fault (defined, approximate, assumed)	
Thrust fault (defined, approximate, assumed)	
Zone of numerous imbricate thrust faults	
Bedding, tops known (horizontal, inclined, vertical, overturned)	
Bedding, tops unknown (horizontal, inclined, vertical, dip unknown)	
Pillow bedding, tops known (inclined, vertical)	
Flow banding (inclined, vertical)	
Fracture cleavage (inclined, vertical)	
Syncline, showing direction of plunge (defined, approximate)	
Anticline, showing direction of plunge (defined, approximate)	
Antiform (horizontal, plunging, overturned)	
Synform (horizontal, plunging, overturned)	
Minor fold axis (with plunge)	
S-folds, Z-folds	
Gneissic foliation (horizontal, inclined, vertical, dip unknown)	
Schistosity, cleavage, foliation (horizontal, inclined, vertical)	
S_1, S_2	
Foliation due to thrusting (inclined, vertical)	
Lineation, fold axis, mineral rodding	

Jointing (horizontal, inclined, vertical)	
Primary igneous layering (inclined)	
Shear zone (approximate)	
Alteration zone	
Unconformity	
Contact inferred from magnetic anomaly	
Glacial striae	
Drift covered area	
Topographic lineaments from aerial photographs	
Road	
Power transmission line	
Mine	⚒ Pb
Mineral Occurrence	× Zn
Location of measured section	

Abbreviations

Arsenopyrite	asp	Iron formation	i-f
Asbestos	asb	Magnetite	mag
Chalcopyrite	cp	Molybdenite	mo
Copper staining	cs	Pyrite	py
Fluorite	fl	Pyrrhotite	po
Galena	gn	Radioactive minerals	ra
Hematite	hem	Serpentine	sup
		Sphalerite	sp

Chemical symbols are used for elements, e.g. Cu......copper.

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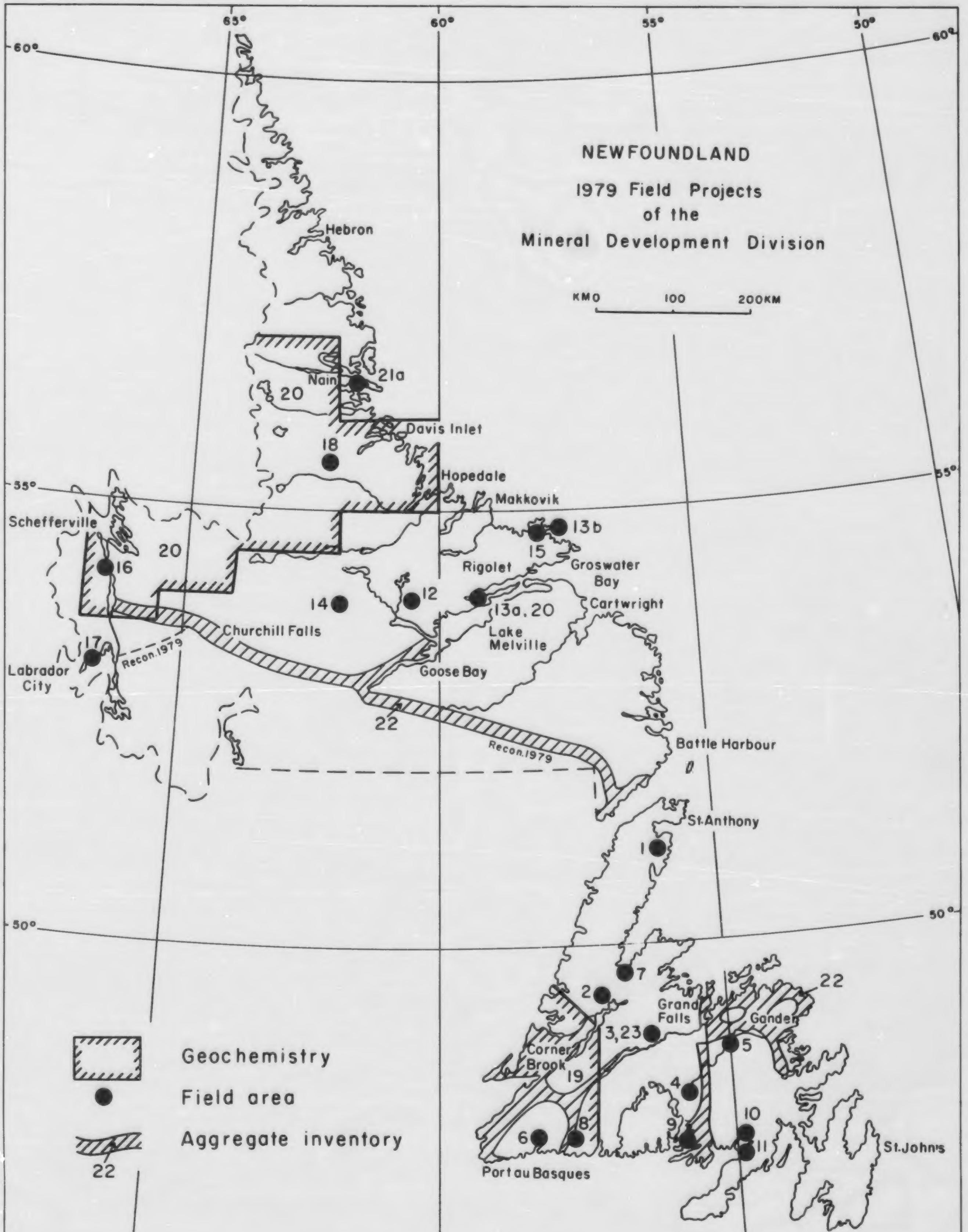

NEWFOUNDLAND

1979 Field Projects
of the
Mineral Development Division

65°
60°
55°
50°
60°
60°
55°
55°
50°
50°
65°
60°
55°
KM 0
100
200 KM
Hebron
Nain
21a
20
Davis Inlet
18
Hopedale
Makkovik
13b
15
Schefferville
20
16
Groswater Bay
Rigolet
14
12
13a, 20
Cartwright
Churchill Falls
Lake Melville
17
Labrador City
Recon.1979
Goose Bay
22
Recon.1979
Battle Harbour
St.Anthony
1
7
2
22
Grand Falls
Gander
3,23
5
Corner Brook
19
4
9
10
11
8
6
St.John's
Port au Basques
Geochemistry
Field area
Aggregate inventory
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GEOLOGICAL MAPPING OF PARTS OF THE EDDIES COVE, SALMON RIVER AND ADJACENT MAP AREAS

by

I. Knight

INTRODUCTION

1:50,000 scale mapping of the Eddies Cove map area begun in 1977 (Knight and Edwards 1978a) continued during the summer of 1979 and mapping commenced on the northwestern part of the Salmon River area (12P/1). Mapping also extended into adjacent areas of the Brig Bay and Flowers Cove maps and led to some partial reassessment of earlier work in these areas (Knight and Edwards 1978b, Knight and Snow 1979).

The area mapped underlies generally low lying topography. Extensive peat bogs cover large tracts of ground and are separated by hills and linear ridges of tight tuckamore spruce or open evergreen forest. In general, peat bogs mostly overlie nonporous Cambrian dolostones and forests overlie limestones and gradually become dominant in the east. Lakes are scattered throughout the area. Outcrop is poor in the peat bog areas but elsewhere good to broken outcrop occurs around edges of smaller marshes, on ponds, in streams and on the ridges and hills. The area is surprisingly free of glacial drift cover and many areas, particularly those underlain by Watts Bight dolomite and mixed lithologies of the "unnamed" formation are often barren of cover.

Geological Setting

The map area lies within the western platform of the Newfoundland Appalachians and includes predominantly carbonate rocks of Cambrian and Lower Ordovician age with minor siliciclastic rocks. Middle Ordovician strata previously thought to occur extensively in the area (Cumming, in Bostock *et al.*, 1976) has only been positively identified in a thrust bound slice in the east of the area. The strata has been subdivided using the lithostratigraphic subdivisions proposed by Knight (1978) and the mapping is essentially a continuation of existing mapping partially completed to the north of the present area.

STRATIGRAPHY

Cambrian

Three rock units of Cambrian age were mapped in the area.

1) Hawke Bay Formation

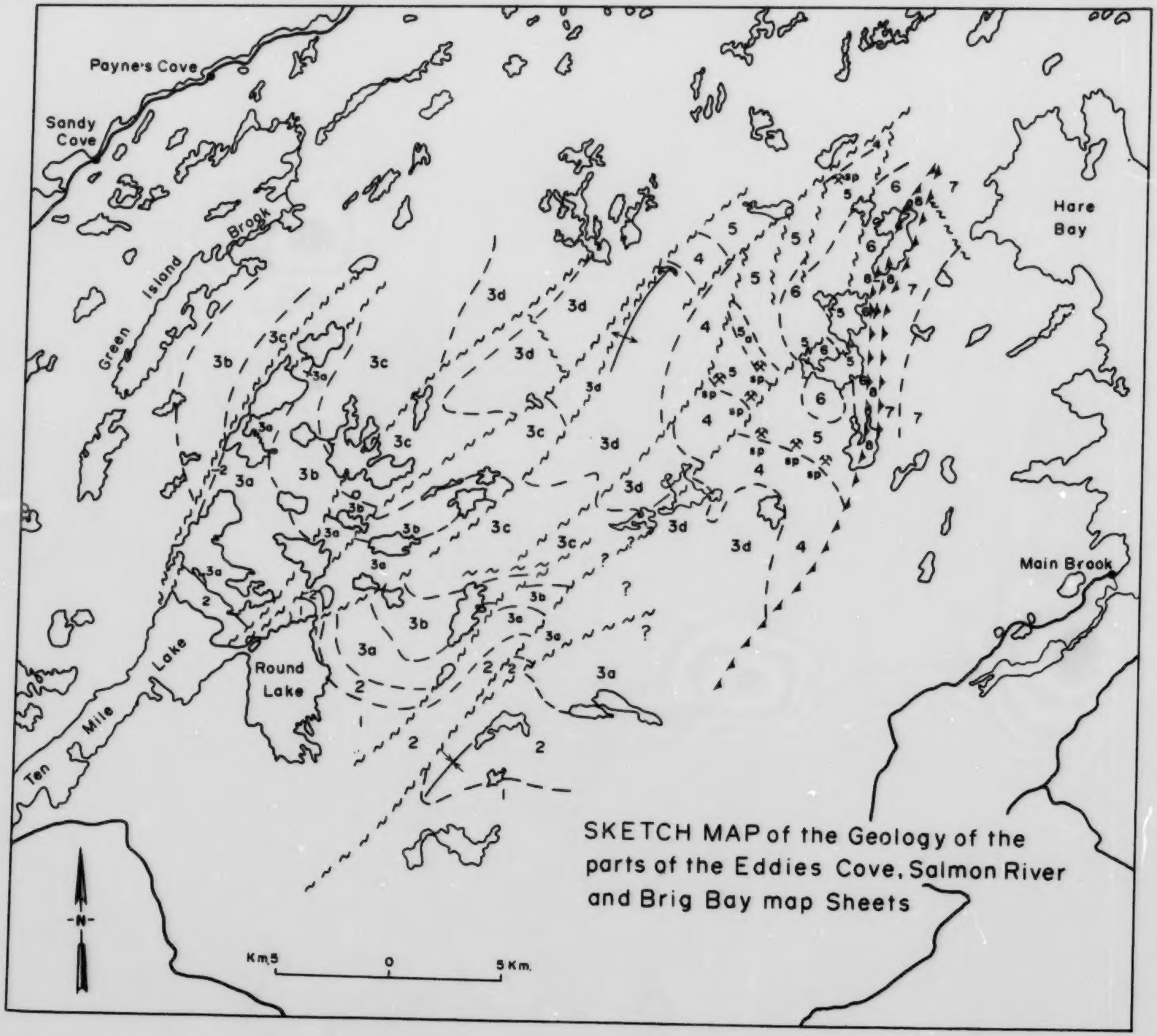
This map unit of upper Lower Cambrian age (Knight, 1977) is poorly exposed. It outcrops in the southern part of the area east of Round Lake and in the vicinity of Rubes Steady. It consists of thick beds of white, coarse and very coarse grained quartz arenite with some interbedded units of thinly stratified green-gray, argillaceous, fine to medium grained sandstones and shales. Large scale crossbedding and planar stratification are common in the quartz arenites.

2) Micrite formation

Limestones and dolomitized limestone of the Micrite formation are exposed in scattered outcrops in the south and western parts of the map area. It is composed of blue-gray, stratified micritic limestones and argillaceous micrites. Bioturbation is variably developed and dolomitization of burrows

LEGEND

MIDDLE ORDOVICIAN			
8	Table Head Formation		
LOWER ORDOVICIAN			
	St. George Group		
6	Catoche Formation	7	Limestone and dolomitic limestones in thrust slice, probably equivalent to units 5 and 6.
5	'Unnamed' formation		
4	Watts Bight Formation		
CAMBRIAN			
3	Dolomite formation	3d	Cherty dolostone member
		3c	Upper dolostone member
		3b	Stromatolite member
		3a	Lower dolostone member
2	Micrite formation		
	Labrador Group		
1	Hawke Bay formation		


Payne's Cove
Sandy Cove
Green Island Brook
Hare Bay
Main Brook
Round Lake
Ten Mile Lake
-N-
Km5
0
5 Km.
2
3a
3b
3c
3d
4
5
5a
6
7
8
sp
?

SKETCH MAP of the Geology of the parts of the Eddies Cove, Salmon River and Brig Bay map Sheets and along bedding is common. The upper part of the formation is dolomitized to form a rusty weathering, finely crystalline, black to dark gray dolomite. Intercrystal and fenestral porosity (Choquette and Pray, 1970) is well developed and the strata retains its original thin, wavy to planar stratification. The formation is Middle Cambrian in age (Boyce, 1978).

3) Dolomite formation

A very widely distributed assemblage of dolomite strata, the Dolomite formation, overlies the limestones. The formation is composed of light gray to gray dolostones and gray, black, buff and white, finely crystalline dolomites.

In previous studies, the Dolomite formation was defined to include three lithological members (Knight, 1977, 1978). However, it is now proposed to include the overlying Unfortunate Cove formation (Knight, 1977, 1978) in the formation and to refer to it as the cherty dolomite member.

The formation is generally poorly exposed. However, definition of the stromatolite member between the lower and upper dolostone members and the location of a marker bed of dark gray to black, cherty stromatolite and bioturbated dolomite at the base of the cherty dolomite member (see Knight, 1978; Snow and Knight, 1979) allow ready mapping of the subdivisions of the formation.

The lower and upper dolostone member (map units 3a & 3c) consist essentially of buff to brown, slabby weathering, gray to pale gray, thin to thick bedded dolostones with minor shale partings. Lamination, dessicated disrupted lamination, flat pebble conglomerates, structureless bedding and small stromatolite heads are common. Fenestral porosity and styolites are also common. Some dolarenites composed of well sorted, rounded carbonate sand grains occur in the upper member.

The stromatolite member (map unit 3b) is characterized by yellow colored, blocky weathering, gray, dolostones. Domal stromatolites, formed of large spherical heads with faint crinky lamination and styolites parallel to the domal morphology of the mounds, are characteristic of the member. Other thick stromatolite beds are composed of flat lying crinkly lamination, again rich in styolites and some fenestral porosity. The stromatolites were built up in vertical, flat topped, pillars, 40 to 100 cm wide and up 100 cm high. These are separated by narrow 10 cm wide intermound areas filled with intraclastic dolostones and crossed at intervals by algal laminae. Red, iron rich, finely laminated crusts cap many of the stromatolite heads. Mudcracks have been observed on tops of some domal stromatolite mounds. Intraformational edgewise conglomerates, dolarenite and thinly stratified dolostones are associated rock types. Flaser and lenticular bedding (Reineck and Singh, 1975) and quartz sand lenses and laminations are common in the stratified dolostones.

The uppermost cherty dolostone member (map unit 3d) consists of buff weathering, gray to blue-gray dolostones and dark gray weathering white, dark gray and black, finely crystalline dolomites. Rusty weathering, gray chert is widespread in the member. Bedding is variable in thickness and internal structures vary from lamination, lenticular and flaser bedding, to mottled, bioturbated textures with black shale drapes. Stromatolitic mounds form a basal marker horizon such as that observed at Anchor Point in the Brig Bay map area (see Snow and Knight, 1979). Digitate to columnar SH-V stromatolite forms (Logan *et al.*, 1964) are common in this unit and in other stromatolite beds in the member. Porosity may be open in some of these stromatolites but overall the member is generally nonporous. A tan-gray weathering, bioturbated, fine crystalline dolomite unit forms a widespread unit at the very top of the formation. It is equivalent to a unitdescribed by Knight (1977,1978) in coastal exposures near Watts Bight and Lower Cove in the Big Brook map area to the north of the present map area.

Ordovician

Both Lower and Middle Ordovician strata have been identified in the area. However, the sequence is structurally dissected. The complete sequence of the Lower Ordovician St. George Group as defined on the western side of the Northern Peninsula (see Knight 1978) is incomplete in the map area. Only three lithostratigraphic units were defined. Middle Ordovician strata consisting of uppermost limestones of the Table Head Formation and overlying shales occur in a thrust bound slice.

Lower Ordovician - St. George Group

The base of the St. George Group begins at a major change in character and lithology from the Upper Cambrian dolostones of the Dolomite Formation. The contact is sharp and apparently conformably throughout the Northern Peninsula. Three units have been identified in the group in the map area.

Watts Bight formation (map unit 4)

This is an important and easily identified rock unit consisting of black to gray bituminous, medium to coarse crystalline dolomites with abundant black chert. The most characteristic feature of the unit is a light gray to cream colored mottling of the black dolomite because of extensive bioturbation in the dolomitized carbonates. The dolomites are interrupted by a thin limestone unit in the middle of the formation and above this limestone the dolomites tend to be slightly lighter in color and in places are a honey-brown color. The dolomites weather tan to black and decompose to a friable, sugary dolomite sand. The unit is generally composed of massive, thick beds with expansive, flat bedding planes. The beds are cut by well developed joints along which solution weathering and frost heaving contribute to produce massive blocky outcrops. Large and small stromatolite mounds and heads, mostly of SH-C and SH-V growth forms occur in the dolomites. Laminated and stratified dolomite beds also occur. Intercrystal and fine fracture porosity now closed by white sparry dolomite, is common as well as larger cavities and megapores (Choquette and Pray, 1970). Brecciation may fill the cavities which are lined by spar and in places filled by cream colored geopetal mud. Other solution breccias especially associated with the stromatolites also occur.

The limestone unit in the middle of the formation was mapped at the northwestern part of the map area. It consists of bioturbated, bedded micrite associated with a bioturbated, black dolomite bed with shaly drapes.

"Unnamed" formation (map unit 5)

The "unnamed formation" (Knight, 1978) appears to disconformably overlie the Watts Bight formation in the map area. A dolomite-chert breccia horizon cemented by chert and fine crystalline dolomite overlies the Watts Bight dolomites at a number of localities just west of Vee Pond. Remaining porosity is filled by white sparry dolomite. Breccia-filled fractures penetrating vertically into the upper strata of the Watts Bight formation were also observed in the same area. This breccia and fracture feature is interpreted as a "disconformity" although it may represent a stratabound collapse breccia possibly related to solution of evaporites (see James, 1979). A similar breccia horizon was also discovered in the Roddickton map area (see Knight and Saltman, this volume) at the same contact. A breccia zone is also recorded on Boat Head (S-10, figure 5, Knight, 1977) above the uppermost Watts Bight dolomites. It may also represent a disconformity but has not been re-examined in the light of the recent discoveries.

Overlying the basal breccia, the formation consists of interstratified units of pale gray weathering, dark gray, platy stratified micritic limestones, bioturbated micritic limestones, yellow weathering laminated dolomitic limestone, laminated and stromatolitic limestones and secondary dolomites.

A well stratified, buff weathering, pale gray dolostone containing rusty chert layers forms an important unit in the middle of the formation from the western edge of Vee Pond to the vicinity of the Round Pond zinc deposit. The dolostones are mostly laminated but also include crosslamination and lenticular bedding and some small stromtolite heads. It overlies a ridge composed of black Watts Bight type dolomite.

Above these units, bioturbated bioclastic and stromatolitic limestones become common. These become interbedded with several units of laminated and mudcracked dolomitic limestone and siliceous dolostones which mark the top of the formation.

The "pebble bed" disconformity described at Boat Harbour (Knight, 1978) near the top of the formation occurs at a number of localities on Middle and Whale Ponds. Siliceous sand and pebble sized detritus consists of chert and chalcedony grains set in a buff weathering, fine crystalline dolomite matrix. The detritus is angular to rounded and usually poorly sorted. A thick breccia, composed of large clasts of mixed dolomite lithologies and some chert occurs at approximately the same horizon west of Commodore Pond and may be related to the disconformity. The disconformity is now known to be of regional importance being identified lithologically on the Port au Port Peninsula (Pratt, personal communication, 1979) and identified biostratigraphically in western Newfoundland (Boyce, 1979; Stouge, in press).

Secondary dolomitization is especially common in the lower part of the formation where limestones are replaced by black gray and honey colored mottled to vuggy dolomites, salt and pepper textured dolomites and pseudobreccias. Porosity was opened as elongate channel to irregular shaped vug porosity and as megapores (Choquette and Pray, 1970). White sparry dolomite partially to almost completely fills the porosity. Where infill is complete the rock has been generally called a "pseudo breccia" (Cumming, 1968; Rhodes, 1970, 1971).

Catoche Formation (map unit 6)

The Catoche Formation consists of rubbly weathering, dark gray limestones and lies conformably above the last laminated and mudcracked dolomitic limestone of the "unnamed formation". The Catoche Formation consists essentially of well bedded, bioturbated micrites and biomicrites with lenses of bio- and intraclastic calcarenites and calcrudite. Beds vary in thickness and are composed of thin, lenticular stratification which is usually heavily bioturbated to give a knobbly form to the bedding. Dolomitization of burrows is widespread. Fossil debris is seen in the limestones but only planispiral gastropods are readily identified.

Black crystalline, bituminous dolomites replace the limestones at a number of localities near Middle Pond but no extensive dolomite units were traced, possibly because of inadequate exposure in that area.

Map unit 7

Rocks resembling the "unnamed formation" and the Catoche Formation were mapped east of a thrust fault trending from Commodore Pond south to Vee Pond. Lithologies strikingly similar to the upper part of the "unnamed formation" including bioturbated, bioclastic micrites and laminated dolomitic limestones and some beds of laminated siliceous dolostones occur.

These are overlain by bioturbated limestones possibly equivalent to the Catoche Formation.

Alternatively, the rocks could represent strata of upper lower and lower Middle Ordovician age. These could include rocks equivalent to the Siliceous Dolomite formation below the Table Head Formation (see Knight, 1977, figure 6, S-14), and transitional limestone which occur immediately below rubbly limestones of the Table Head Formation proper. Conodont studies supporting the present mapping program may resolve this problem.

Middle Ordovician

Middle Ordovician strata belonging to the Table Head Formation and the overlying Goose Tickle Formation (Tuke, 1968; Smyth, 1973) is only positively identified in the thrust slice lying along the trace of Commodore Pond to Vee Pond (figure 1).

Only 10-15 m of Table Head Formation is exposed in an outcrop at the south end of Commodore Road. It consists of shaly, nodular, blue-black, micritic limestone. Shale content increases upward towards the overlying black shales in which planar limestone beds (2-10 cm) occur. Float collected east of Commodore Pond suggests that green-gray, lithic arenites become interbedded with the shales upwards, typical of the Goose Tickle Formation (Tuke, 1968).

STRUCTURE

The map area is dominated by northeast trending normal faults that dissect and displace the gently dipping strata. The faults, which splay, join and sometimes disappear along their trends, lie parallel to a major fault zone which is known as the Ten Mile Lake Fault system. This system which extends from the northeast end of Ten Mile Lake consists of two faults. Rocks between the faults are uplifted and folded into a narrow anticline. The western fault and all faults west of it are consistently downthrown northwestwards; the eastern fault and all faults east of the system are downthrown southeastwards. The strata between the faults which are spaced at 4 to 8 km apart are usually folded into gently northeast plunging, open synclines. The overall effect of the fault systems is to swing north-trending eastward dipping strata in the west, to east-trending north dipping strata in the east. Beds are usually gently inclined between 2° to 15°. This easterly trend is truncated by a zone of north-trending thrust faults. Two main thrusts occur with associated minor thrusts. Above the lower thrust fault, Middle Ordovician strata is thrust over limestones of the St. George Group. Within this thrust slice Table Head limestones are thrust over black shales. The upper thrust fault carries rock units believed to be of Lower Ordovician age over the Table Head and Goose Tickle Formation. Cleavage and minor folds are developed within and close to the thrust zone.

MINERALIZATION

The map area contains many occurrences of sphalerite mineralization and includes the Round Pond sphalerite deposit estimated to contain 150,000 tons of 2.5% Zn (Rhodes, 1970, 1971). The sphalerite mineralization is stratabound and is restricted to the lower part of the "unnamed formation". Showings occur in the basal dolomite-chert breccia and consist of disseminated green sphalerite crystals. Sphalerite is, however, more widespread in porous dolomites, pseudobreccias and salt and pepper textured dolomites in strata above the basal unit. Rhodes (1970, 1971) also describes mineralization occurring in collapse breccias. The sphalerite is reddish brown to green-yellow and occurs as disseminations, clots, and large crystals within the secondary dolomites and rarely within adjacent limestones. White sparry dolomite fills much of the porosity associated with mineralized and unmineralized dolomites. The showings weather to a rich ochre-yellow.

Drill core from the Round Pond area suggests abundant solution collapse breccias occurred associated with the Round Pond deposit (Rhodes, 1970, 1971). Pyrite up to 1-2% but locally up to 95% over 30 cm occurs throughout the Round Pond area. Examination of drill logs indicates that pyrite-rich rock lies between unmineralized and zinc bearing strata.

No zinc mineralization was found in the dolomites replacing the Catoche Formation near Middle Pond although equivalent strata northeast of Commodore Lake includes Cominco showing No. 7 which assayed 1.6 to 14.7% zinc (Cajka, 1969). Here the sphalerite is reported to occur in pseudobreccia dolomites.

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PLATFORMAL ROCKS AND GEOLOGY OF THE RODDICKTON MAP AREA, GREAT NORTHERN PENINSULA

by

I. Knight and P. Saltman

INTRODUCTION

1:50,000 geological mapping of the Cambro-Ordovician platformal rocks of the Roddickton map area commenced in the summer of 1979. The platformal rocks form a southward narrowing terrain of low elevation between the high mountains of the Long Range Mountains on the west and a slightly lower range of hills on the east. Narrow arms of the sea penetrate the area from south to north. The area overlying the platformal rocks is heavily forested with a few lakes and small marshes. Large areas of forest have been cut-over in the north; some of these cut-overs were later burned by a major bush fire in the late sixties. Access to the area by seas, highway and woods roads is good. Outcrop is present in many parts of the forest although not easily located.

Geological Setting

Three geological terrains occur in the Roddickton map area (fig. 2).

1. Precambrian crystalline basement (map unit 1, fig. 4) underlies the Long Range Mountains in the western part of the map area. Grenvillian gneisses and a variety of granites with associated pegmatite dikes cut by a northeast trending diabase dike swarm (Williams *et al.*, 1974a) occur in this terrain.

2. Cambro-Ordovician platformal strata (map units 2 to 7) unconformably overlying the Precambrian basement, occur in the central part of the area. The sequence includes both siliciclastic and carbonate rocks of Lower Cambrian to Middle Ordovician age. Minor volcanics also occur near the base of the sequence.

3. Allochthonous sedimentary and volcanic rocks of the Hare Bay Allochthon (map unit 8) structurally overlie the platformal terrain in the eastern part of the area (Smyth, 1973).

Mapping of the platformal terrain attempted to apply previously established lithostratigraphic subdivisions for the Cambro-Ordovician platformal rocks of the Great Northern Peninsula (see Knight 1978). This was partly successful in the northwest but is complicated for the rest of the area by a number of factors. These include:

A. Distinct lithological changes occur within the platformal sequence in the map area. These changes occur across north to northeast trending normal faults, called the Saltwater Cloud Pond, Shoal Pond and Hatters Pond Faults (see fig. 2) and reflect changes of depositional environment.

B. The platformal sequence is deformed to varying degrees. The intensity of deformation increases eastward and southward as the platformal rocks are pinched between the Hare Bay Allochthon in the east and the buttress of Long Range gneissic basement in the west. Metamorphism and recrystallization has affected the carbonates changing their character and appearance.

C. Thrust faulting has produced major repetitions of the succession in the area. This is further complicated by later northeast trending faults that offset both the stratigraphy and the thrust faults.

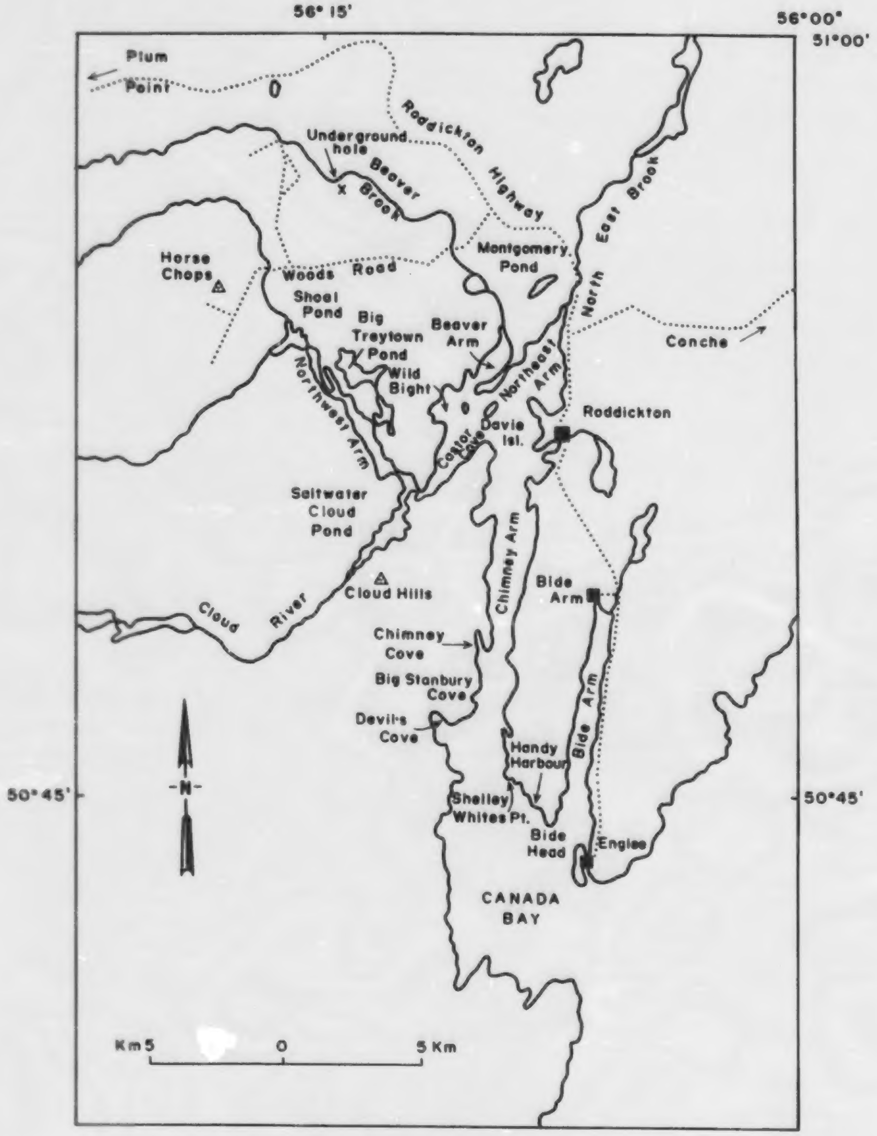

56° 15'
56°00'
51°00'
Plum Point
Roddickton Highway
Underground hole
Beaver Brook
North East Brook
Montgomery Pond
Horse Chops
Woods Road
Shoal Pond
Big Treytown Pond
Beaver Arm
Conche
Wild Bight
Northeast Arm
Northwest Arm
Roddickton
Castor Cove
Davis Isl.
Saltwater Cloud Pond
Chimney Arm
Cloud Hills
Cloud River
Bide Arm
Chimney Cove
Big Stanbury Cove
Devil's Cove
Handy Harbour
N
50°45'
50°45'
Shelley Whites Pt.
Bide Head
Englee
CANADA BAY
Km 5
0
5 Km

Figure I. Location Map of Roddickton Area

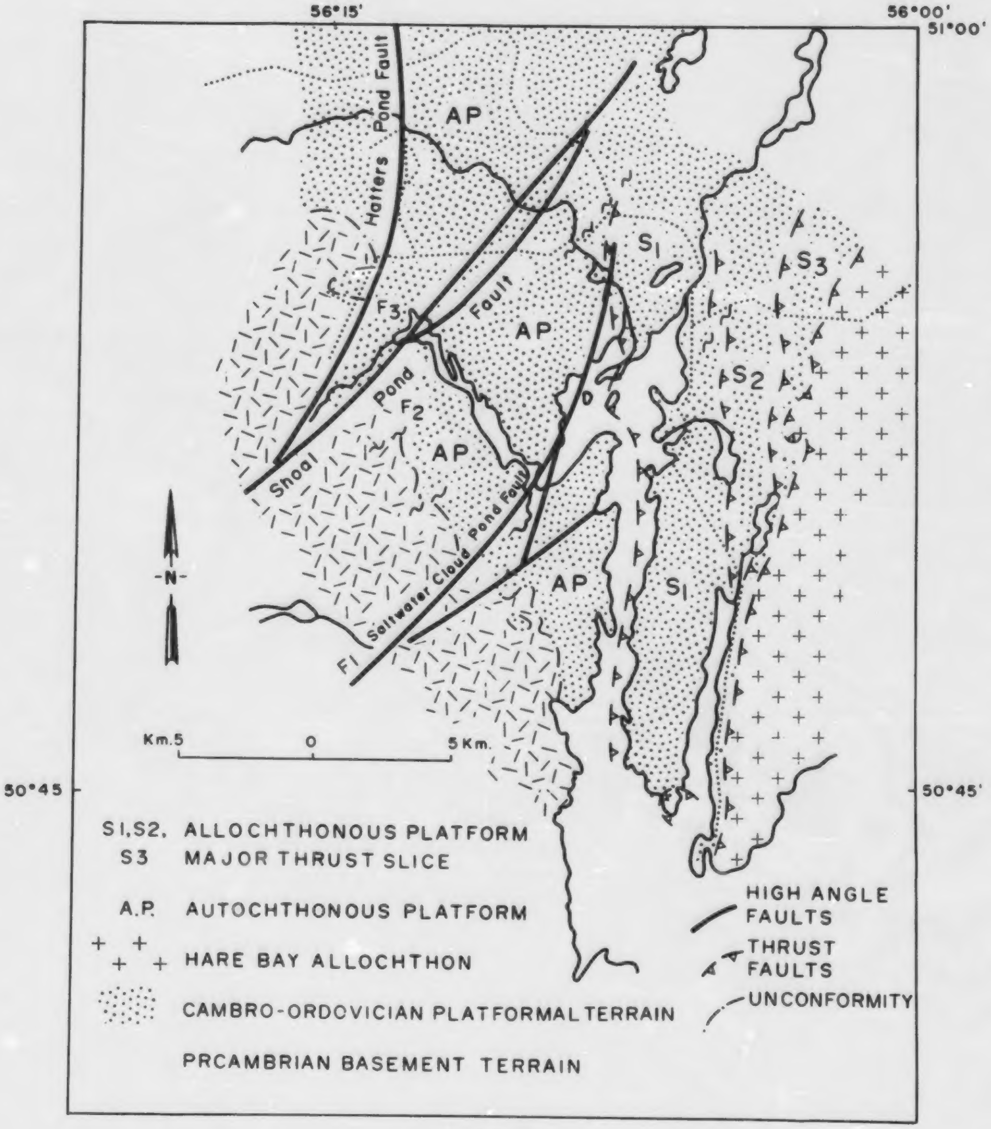

56°15'
56°00'
51°00'
50°45
50°45'
Hatters Pond Fault
AP
Fault
F3
AP
Pond
F2
AP
Shoal
Saltwater Cloud Pond Fault
F1
AP
S1
S1
S3
S2
-N-
Km.5
0
5 Km.
S1,S2. ALLOCHTHONOUS PLATFORM
S3 MAJOR THRUST SLICE
A.P. AUTOCHTHONOUS PLATFORM
HARE BAY ALLOCHTHON
CAMBRO-ORDOVICIAN PLATFORMAL TERRAIN
PRCAMBRIAN BASEMENT TERRAIN
HIGH ANGLE FAULTS
THRUST FAULTS
UNCONFORMITY

Figure 2

Generalised Map Showing Major Geological Elements of Roddickton Area includes Faults (F1, F2, F3) believed to have influenced sedimentation in the area

STRATIGRAPHY

The platformal sequence can be conveniently divided into four sequences.

1. A Lower Cambrian mixed siliciclastic and carbonate sequence referred to as the Labrador Group.

2. A Middle to Upper Cambrian carbonate sequence.

3. A Lower Ordovician carbonate sequence, the St. George Group.

4. A Middle Ordovician limestone and shale sequence, the Table Head and Goose Tickle Formations.

Labrador Group (map unit 2)

The Labrador Group consists of a mixed siliciclastic and carbonate succession with some localized mafic volcanics. The basal strata of the group which may be either pebbly arkosic sandstones or mafic volcanics unconformably overlie Precambrian basement along the west side of the area.

Oxidation, reduction and destruction of the textures of the gneisses below the unconformity occur locally and suggest that a regolith is locally preserved.

Four lithological units occur in the group in the map area.

A) Volcanic Rocks

These are tholeiitic, predominantly subaerial mafic volcanics (Strong and Williams, 1972; Strong, 1976). They occur in a number of isolated outliers upon Precambrian basement or may overlie a few metres of arkosic sediment (Smyth, 1973). A narrow fine grained diabase dike probably related to the volcanism cuts through to the top of the basal arkose unit where it becomes concordant to bedding.

B) Basal arkosic unit (Bradore Formation)

This unit sits unconformably upon Precambrian basement and consists of about 62 m of red to purplish-red pebbly arkose, arkosic sandstone, minor conglomerate and black to purple haematitic sandstones and a yellow weathering, dolomitic limestone. The arkoses are generally poorly sorted, coarse grained, crossbedded, with some planar stratification. Minor thin siltstone and mud partings occur and are usually mudcracked. The hematitic sandstones, however, are mostly very fine grained, micaceous with numerous shaly partings. Thin planar stratification, lamination, flaser bedding and some crossbedding are the main sedimentary structures.

The succession is divided into a lower arkosic sequence with a thin basal conglomerate, overlain by the hematitic sandstones which is capped by the dolomitic limestone and overlain by an upper arkosic sequence. The limestone is eroded and enclosed as clasts in a conglomerate at the base of the upper arkose. Other pebbles in the conglomerate include pisolitic ferruginous intraclasts mixed with quartz pebbles.

The formation was probably deposited by braided streams on alluvial fans. These sediments were derived from the northwest and southwest marginal to a Precambrian highland under semiarid conditions. The finer grained hematitic sandstones were, however, probably a more distal alluvial plain or perhaps a shallow marginal marine facies.

C) Siltstone-shale-limestone unit (Forteau Formation)

Green-gray, pyritiferous calcareous siltstones, black to gray shales, black, gray and mottled pink and cream colored limestones and some thin sandstones comprise the second formation of the Labrador Group. The base is placed at a cleaved, pink and cream colored limestone, the Devils Cove Limestone (Betz, 1939). Above the limestone, the formation is well bedded consisting of beds of laminated calcareous siltstone separated by thin shales and enclosing nodular limestone or limestone beds. The limestones are generally finely crystalline and some are highly fossiliferous, containing abundant *Salterella*. Thinly laminated and crosslaminated sandstones occur in the upper part of the formation. Slumping and channels are recognized locally in the formation.

A black shale sequence with thin black limestones and some black laminated siltstones occurs in the middle of the formation. The unit is highly deformed and rich in folded quartz and calcite veins and tension gashes. A single trilobite fragment of *Olenellus (Paedumias) Transitans* (Walcott) (Boyce, personal communication, 1979) was recovered from the unit. A coarsening upward black, limestone unit occurs a few metres above the black shales. It consists of micrite, fine calcarenite, oolitic calcarenite and is capped by an oncolitic, oolitic calcarenite.

The lithologies of the formation are characteristic of outer shelf muddy siltstones, deposited under generally low energy conditions. The black shale probably marks a platform wide period of tectonic stability and possible climatic change and reflects generally stagnant basin conditions that existed at this time throughout the Northern Peninsula area.

D) Oolitic limestone-mudstone-quartzite formation

The upper formation of the Labrador Group is a mixed assemblage of oolitic limestones, mudstones, shales, sedimentary quartzites, dolomites and dolomitic sandstones. The unit is approximately 90 m thick and is probably laterally equivalent of the quite different Hawke Bay Formation (Knight, 1977) of the western side of the Northern Peninsula. The change occurs across the Hatters Pond and Shoal Pond Faults and further variations occur across the Saltwater Cloud Pond Fault. The lithologies are arranged in three cycles consisting of oolitic with some stromatolitic and oncolitic limestones and dolomites at the base overlain by dark brown weathering mudstones with some units of sedimentary quartzite.

The oolitic limestones are well stratified, lenticular wavy bedded or crossbedded. They include layers and lenses of oncolites, and also intraclasts derived from erosion of cemented oolitic limestones. Large and small sinuous ripple marks also occur. Stromatolites form layers of discrete club-shaped heads or broad, flat topped mounds within or at the top of the oolites. The dolomites occur mostly in the upper cycle and are also crossbedded.

The overlying mudstones enclose thin sandstone and quartzite beds. The mudstones are generally poorly bedded, lenticular bedded and in places exhibit crosslamination. Sedimentary deformation features such as sandstone dikes, ball and pillow structures and convolution are very common. Sandstones and 1-2 m thick sedimentary quartzite within the mudstones are usually rusty weathering, white, fine to medium grained, although one unit in the upper part of the formation contains angular, very coarse, pink feldspar sand grains. Thin planar stratification and large scale cross-stratification is common in the quartzites. Some thin, laminated dolomite beds occur in the mudstones in the upper cycle.

North of the Saltwater Cloud Pond Fault, the lithologies change with the appearance of sandy dolomites and dolomitic sandstones, interbedded with quartzites replacing much of the oolitic limestone-mudstone sequence. Mudcracks, crosslamination, crossbedding and intraformational breccia are common structures. A pink oolite bed forms a marker horizon in this part of the area. Shales and bioturbated shaly sandstone are common at the top of the formation. U-shaped burrows, *Corophoides* and simple tubular burrows are common trace fossils. Mudcracks occur at the base of the shaly sandstone.

The upper formation of the Labrador Group was deposited in a series of oolitic carbonate sand shoals probably forming at the shallow, high energy margin of the shelf. At times, it is possible these shoals were subaerially exposed as islands so that stromatolite complexes developed in the associated shallow shorelines. North of the Saltwater Cloud Pond Fault, intertidal carbonate flat sedimentation occurred probably in the lee of protective barriers formed by islands. The mudstones interlayered with the oolitic limestones may have been deposited westward of the oolite barrier whose geographical position likely migrated depending upon the volume of terrigenous sedimentation on the inner shelf. Alternatively, the mudstones may also represent periods when oolite formation was terminated by the influx of terrigenous material onto the shelf margin. The mudstones and thin sandstones are characteristic of mud dominated outer shelf deposits (Johnson, 1978). The thicker quartz sands are probably distal storm deposits washed eastwards from the inner sand dominated shelf represented by the Hawke Bay Formation. The abundance of sandstone dikes and sedimentary deformation in the mudstones probably reflects the tectonic instability of the shelf margin at this time.

Cambrian carbonate sequence (map unit 3)

The Cambrian carbonate sequence consists of two formations, the lower, consisting of limestone and the upper of dolomite.

A) Limestone formation (Equivalent to Micrite formation, Knight, 1978)

This unit overlies sharply and conformably the upper unit of the Labrador Group. It is approximately 80 m thick and consists of black to dark gray, argillaceous micrites, stratified micrites, bioturbated micrites with lenses of calcarenite and calcrudite, and oolitic limestones associated with a single unit of stromatolite. The base of the formation is usually dolomitic and shaly especially north of the Saltwater Cloud Pond Fault. Slumping of the limestones is common in the lower half of the formation. A 3-4 m bed of oolitic limestones with oncolites preserved at the top occurs in the upper part of the formation along Chimney Arm. The stromatolite bed consisting of domal mounds of SH-C and SH-V growth forms (Logan *et al.*, 1964), is associated with this oolite unit at Big Treytown Pond and at the mouth of Saltwater Cloud Pond.

Fauna collected from the formation includes the trilobites *Ehmania borealis* (Howell) and *Spencella (Solenopleura) pro'Avita* (Howell), and the inarticulate brachiopods *Patorina rotunda* Howell and *Micromitra cloudensis* (Howell) (Boyce, personal communication, 1979). These indicate an upper Middle Cambrian age.

B) Dolomite formation (equivalent to Dolomite and Unfortunate Cove formations, Knight 1978)

This formation which is at least 318 m and probably as much as 400 m thick consists of pale gray to dark gray, dolostones, gray to white, fine crystalline dolomites, dark gray to black, cherty dolostones and dolomites, green-gray dolomitic shales and minor black shales. It gradationally overlies the Middle Cambrian limestones. The formation includes strata equivalent to the Dolomite formation and Unfortunate Cove formation (Knight, 1977, 1978). The latter is now referred to as the cherty dolomite member of the Dolomite formation (see Knight, this volume). Only the cherty dolomite member of the formation can be distinguished in the area; the other lithological members of the Dolomite formation described by Knight, (1977, 1978, this volume) are not distinguishable.

In general, the formation consists of repetitive carbonate sequencs 2-5 m thick. These consist of dolostones and dolomitic shales or dolostones, stromatolites and dolomitic shales, in the lower 41 m of the formation. In the rest of the formation, sequences of mottled dolomites and dolostones, or dolarenites and dolostones with or without stromatolites occur together with some sequences of dolostone and dolomitic shale. The upper part of these sequences consisting of dolostone and/or dolomitic shale are usually very rich in subaerial features. These include mudcracks, dessication polygons, tepee structures, intraclastic, rip up breccias and pavements, fenestral porosity and some pseudomorphs of anhydrite. Small straight ripple marks also occur. Dolarenites may be oolitic or intraclastic and are usually crossbedded. Stromatolites are mostly isolated, domal mounds rich in styolites but generally lacking good internal structure. The mottled dolomites were originally thinly stratified and shaly before organic reworking and small scale soft sediment deformation which gives a knobbly appearance to the beds.

Interbedded at intervals through these repetitive sequences are thick bedded dolostone and dolomite sequences. These are well bedded and either of mottled dolostones, or of several beds of stromatolites. The latter are generally poorly defined and only bedding plane morphology aids in interpreting them as stromatolites. A thick unit of bedded dolostones consisting of alternating beds of fracture and fenestral porosity (Choquette *et al.*, 1970) lined by pink dolomite crystals forms a marker bed from Montgomery Pond to Shelley Whites Point. A collapse breccia disrupting stromatolites and stratified dolostones occurs at the top of a thick bedded and stromatolitic section at Shelley Whites Point, 67 m above the base of the formation.

The cherty dolomite member is well exposed in the area and consists of black and dark gray mottled dolomites and stromatolitic, fine crystalline, dolomites interbedded with buff weathering, mudcracked, pale gray dolostone. Chert layers are abundant. The base of the member is drawn at a sequence of large, stromatolite mounds and is well exposed on the shores of Northeast Arm. These mound horizons are correlated with similar mounds on the western side of the Northern Peninsula (Snow and Knight, 1979).

No fauna has been found in the formation in the area but is probably Upper Cambrian in age.

The dolomites were deposited predominantly in shallowing upward intertidal to supratidal and subtidal to supratidal sequences associated with an extensive development of carbonate shorelines and relatively humid hypersaline sabkha flats. Algal mats were widespread in the environment and stromatolite banks were important locally. The carbonates were periodically subaerially exposed leading to solution breccias forming in the thick bedded dolomite sequences.

Ordovician

Ordovician strata in the area includes the Lower Ordovician St. George Group and the Middle Ordovician Table Head and Goose Tickle Formations. The sequence is, however, structually dissected by thrust faults and no continuous section passing from Lower to Middle Ordovician occurs in the area.

Lower Ordovician St. George Group (map unit 4)

The St. George Group consists of three formations in the area.

A) Black dolomite and limestone formation (equivalent to Watts Bight formation, Knight, 1978)

This formation consists of black medium crystalline dolomite, limestone and chert. North of the Shoal Pond Fault, the unit is exclusively dolomite as it is elsewhere on the Northern Peninsula, (for description see Knight, 1977, 1978, this volume) but in the Roddickton area, south of the Shoal Pond Fault the dolomitization is restricted to a few beds totalling only 17 m thick. This thickness decreases southwards to 6 m and is located only at the base of the formation; the majority of which is composed of limestones with only patches of dolomite.

The unit overlies conformably and sharply the Upper Cambrian dolomites and is calculated to be approximately 86 m thick north of Northeast Arm but it probably thins to the southeast.

Large stromatolite mounds, 1-3 m diameter and 40-60 cm high and bioturbated, well bedded, black micritic limestones with layers of black chert nodules characterize the unit in the south. Dolomitization of burrows is widespread. Large coiled and partly coiled gastropods, gastropod opercula and some straight cephalopods occur rarely in the limestones. A few stromatolite mounds at the base of the unit have been observed in the unit in folded and foliated limestones west of Handy Harbour and northeast of Bide Head.

The unit was deposited in response to a major transgression that advanced rapidly westward across the Lower Ordovician platform. The limestones were deposited on the shelf in stromatolite banks and as extensive, subtidal bioturbated lime muds. The stromatolitic component is thinly developed in the southeast and occurs only at the base of the formation, reflecting the rapid transgression.

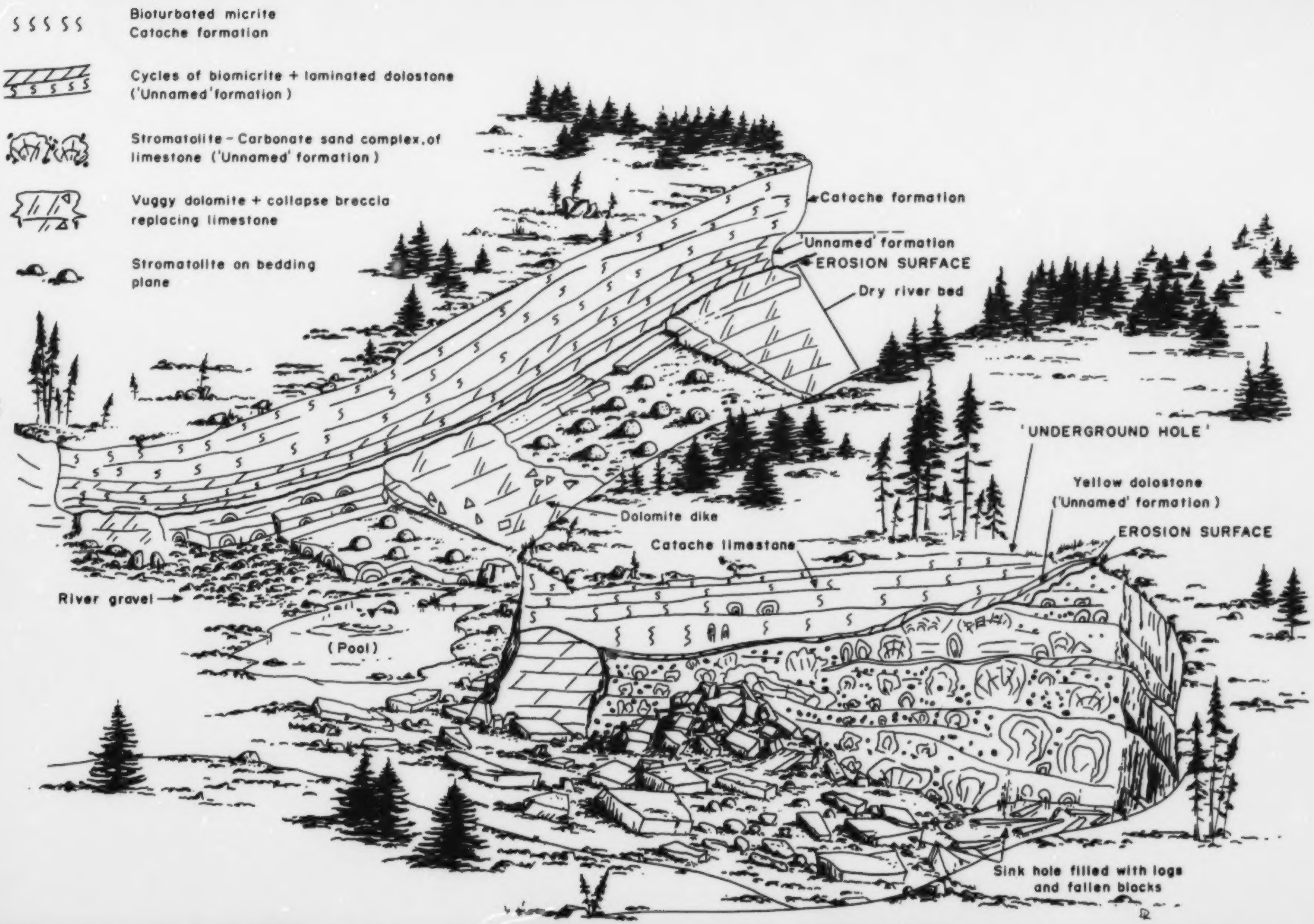
B) Limestone-dolostone formation (equivalent to Unnamed formation, Knight, 1978)

This is generally poorly exposed in the map area. It is best exposed along Beaver Brook and along woods roads west of Beaver Brook. Elsewhere, it is difficult to define due to lack of exposure but lithologies typical of the unit occur in a forest fire burn-over near Roddickton. The thickness of the unit also is variable. North of the Shoal Pond Fault, it is approximately 25 m thick, whereas on the shore near Roddickton, a thickness of approximately 54 m is calculated.

North of the Shoal Pond Fault, the formation sharply overlies the black dolomite of the basal formation of the St. George Group. The contact is probably a disconformity. A breccia composed of angular limestone and dolostone clasts set in a fine crystalline dolomite matrix and extending down into underlying black dolomite occurs at the contact. A similar breccia at the contact of the two units occurs elsewhere on the Northern Peninsula (Knight, this volume). Above the basal breccia, the formation consists of bioturbated and stratified micritic and biomicritic limestones interbedded with stromatolitic limestones and with laminated pale gray dolostones or yellow weathering dolomitic limestones. The lithologies are usually arranged in cycles of bioturbated micrite, stromatolite and laminated, usually mudcracked dolostone or dolomitic limestone. The cycles at the top of the formation resemble those above the "pebble bed" and disconformity at Boat Harbour in the north of the Northern Peninsula (see Knight, 1977, 1978).

A deposit of stromatolitic limestones and bio-intraclastic, sparry, calcarenites, at least 4 m thick occurs just north of the Shoal Pond Fault at the underground hole on Beaver Brook

FIGURE 3. SCHEMATIC DIAGRAM OF THE ERODED STROMATOLITE - CARBONATE BANK COMPLEX AT THE UNDERGROUND HOLE, BEAVER BROOK.


Bioturbated micrite
Catoche formation
Cycles of biomicrite + laminated dolostone ('Unnamed' formation)
Stromatolite - Carbonate sand complex, of limestone ('Unnamed' formation)
Vuggy dolomite + collapse breccia replacing limestone
Stromatolite on bedding plane
Catoche formation
'Unnamed' formation
EROSION SURFACE
Dry river bed
'UNDERGROUND HOLE'
Yellow dolostone ('Unnamed' formation)
EROSION SURFACE
Dolomite dike
Catoche limestone
River gravel
(Pool)
Sink hole filled with logs and fallen blocks

(figure 3). The deposit is transgressed by a downcutting erosion surface. Beneath the erosion surface, vertical dikes of vuggy, coarse crystalline, pinkish gray dolomites and dolomite breccias several to tens of metres wide abruptly replace the limestones of the stromatolite complex. The erosion surface is onlapped by the cycles of the upper part of the formation.

The limestone-dolostone formation is characterized by lithologies deposited in shallowing upward carbonate shoreline sequences including subtidal bioturbated lime muds, intertidal stromatolites and supratidal mudcracked dolostones or dolomitic limestones. These are typical of generally moderate to low energy conditions and indicative of a shallow shelf.

A high energy, stromatolite bank and carbonate sand shoal developed north of the Shoal Pond Fault and probably formed a topographic high in the generally flat lying shelf. This was subsequently subjected to dolomitization, karstification and erosion during a period of subaerial exposure of the platform late in the formation's history. The resulting disconformity probably correlates with the "pebble bed" disconformity at Boat Harbour (see Knight, 1978) since both are overlain by similar cyclic carbonate sequences that are characteristic of the upper part of the formation in both areas and are overlain by limestones of the Catoche formation.

C) Bioturbated, well bedded limestone unit (equivalent to the Catoche Formation, Knight, 1977, 1978)

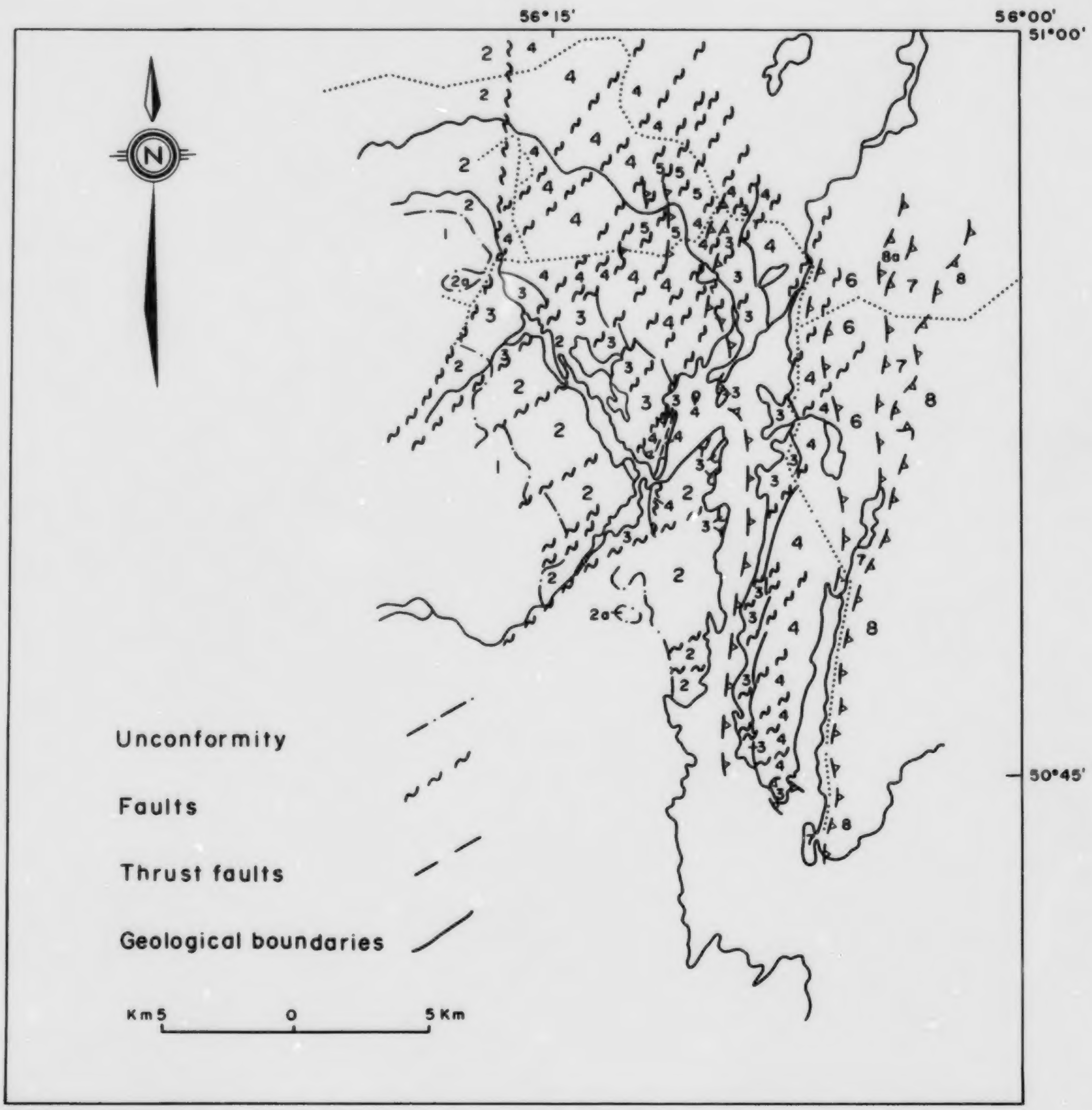
This unit consists of greater than 220 m of rubbly to massive, buff to pale gray weathering, blue-black to dark gray limestones. The formation underlies extensive areas of the northern part of the area and similar lithologies were mapped south to the southern end of the Bide Head Peninsula.

The limestones consist of well bedded, bioturbated micrites and biomicrites with lenses and layers of calcarenite and calcrudite and some layers of black chert nodules. Bedding varies between a few centimetres to 150 cm in thickness. The thickest beds occur in the upper part of the unit where they are associated with erosion surfaces separating beds of varying strike and dip. They probably formed as carbonate mud banks and appear to be more common south of the Shoal Pond Fault. Dolomitization of argillaceous laminae, drapes and burrows is common and locally affects the scour surfaces. Calcarenites and calcrudites occurring in the micrites are composed of rounded intraclasts and fossil debris. Concentrations of coiled and spiral gastropods and straight cephalopods, some of which are silicified or replaced by white calcite spar, are common on bedding planes. The largest fossils were associated with the mud banks. Sponges such as *Archeoscyphia, Receptaculites* and a pedunculate form also occur in the limestones.

Large stromatolite mounds with an irregular dolomite framework and associated with solitary sponges and biocalcarenites occur in the north of the area. The mounds resemble those noted by Knight (1978) northwest of Hare Bay and described by Stevens and James (1977) in Hare Bay. Limestone breccias composed of unbedded to crudely bedded micrite, biomicrite and dolomitic micrite rubble occur west of these mounds.

Crystalline dolomites (diagenetic carbonates of Knight, 1977, 1978) replace the upper part of the limestones north of Roddickton. These consist of dull, pale gray or cream colored dolomite mottles in dark gray dolomites which are bituminous in some beds. Porosity is high and some sparry dolomite and pseudobreccia (Cumming, 1968) is developed.

Trilobites were discovered on a small island near Davie Island. They include *Petigurus nero* (Billings),


56° 15'
56°00'
51°00'
50°45'
Unconformity
Faults
Thrust faults
Geological boundaries
Km 5
0
5 Km

8/8a	Hare Bay Allochthon
7	Deformed shales, limestone of uncertain age, marble and foliated limestone
6	Shale, limestone, dolomite - probably lower to upper Cambrian age
5	Middle Ordovician, Table Head & Goose Tickle Formations
4	Lower Ordovician, St George Group
3	Cambrian carbonate formations
2	Labrador Group (includes volcanic rocks (2a)
1	Pre-Cambrian basement

FIGURE 4

Geological Sketch Map of the Roddickton Area

Bolbocephalus convexus (Billings), *Isoteloides peri* Fortey, *Uromystrum* sp. nov., and *Bathyurina* sp. nov. (Boyce, personal communication, 1979). These are typical of the fauna that occurs in the base of the Catoche Formation at Boat Harbour (Boyce, personal communication, 1979).

The formation was deposited in response to a major transgression that affected the entire Ordovician platform. This produced a deepening of the shelf with deposition of subtidal, lime muds and bioclastic carbonate sands that host an abundant, soft bodied and skeletal fauna. Storms were probably important in fashioning mudbanks, producing erosion surfaces and transporting large quantities of previously deposited sediment across or off the shelf. North of the Shoal Pond Fault, stromatolite mounds with associated sponges and clean carbonate sands reflect a high energy shallower environment that probably formed a marginal shelf edge facies that extended from Roddickton to Hare Bay at this time (see Stevens and James, 1975).

Middle Ordovician (map unit 5)

This consists of the Table Head and Goose Tickle Formations. They are only positively identified in a dissected thrust slice in the Beaver Brook area.

The Table Head Formation consists of well bedded, blue-gray limestones which are massive, thickly bedded, bioturbated, fossiliferous and intraclastic micrites that generally lack dolomitization. Large, straight, cephalopods are common. These limestones are overlain by nodular, thinly stratified and shaly, highly fossiliferous limestone which pass up into black shales with thin limestones. The fauna includes:

Trilobites

Geragnostus sp., *Ampyxoides semicostratus* (Billings), *Niobe morrisi* (Billings) and *Nileid* gen. ind. Whittington (1965) (Boyce, personal communication, 1979)

Graptolites

Cryptograptus? tricornis schaeferi Lapworth, Glyptograptus cf. G. teretiusculus (Hisinger) and *Glyptograptus* sp. undet.(Skevington, personal communication 1979)

Inarticulate and articulate brachiopods and ostracods also occur.

Overlying gradationally is the Goose Tickle Formation composed of black shales and thin, green-gray, sandstones which exhibit flute casts, grading and are mostly internally laminated.

Map unit 6
(lithologies of thrust slice 2)

Three lithologies occur within the map unit which although highly deformed and recrystallized in places, are believed to be a conformable sequence.

At the base of the thrust slice, the sequence commences with dark gray to black, pyritiferous shales which are interbedded upwards with thin black limestones and laminated calcareous siltstones. Beds of oolitic-oncolitic and oncolitic-intraclastic limestones and limestone-conglomerate also occur near the top of the unit interbedded with and overlain by shales.

This unit is overlain by a thinly stratified black limestone which is characterized by yellow dolomitic laminae or thin beds. Scattered oolites and some fossil debris is visible locally. This, in turn, is overlain by a thick bedded, pale yellow weathering, white dolomite. Oolitic beds, mudcracks, disrupted bedding, fenestral porosity and mudflake breccias similar to the Upper Cambrian dolomites are preserved locally.

The lithologies of the thrust slice are correlated with the Lower to Upper

Cambrian authochthonous platform sequences in the west of the map area. The shale and limestone probably represent slope facies laterally equivalent to the shelf margin and outer shelf deposits of the autochthonous platform.

Map unit 7
(lithologies of thrust slice 3)

The dominant lithology of thrust slice 3 consists of cleaved blue-gray limestones and black to gray shales and phyllites. Close to the basal thrust the limestones become white, foliated marbles. The least deformed limestones show dolomitized bioturbation and some fossil debris. Along the Conche road, the limestones are overlain by dark gray shales with silty laminae which are in turn overlain probably structurally by sandstones of the Hare Bay Allochthon.

On the east side of Bide Arm, the limestones are cleaved and foliated and are interleaved with black to green-gray phyllites and shales. Dolomite and thin limestone beds also occur in the phyllites.

The lithologies of the thrust slice are probably of Ordovician age and have been assigned a Middle Ordovician age in previous studies (Smyth, 1973).

CAMBRIAN AND LOWER ORDOVICIAN PALEOGEOGRAPHY OF THE RODDICKTON AREA.

Sedimentation in the area began in the Lower Cambrian with predominantly siliciclastic deposition involving fluvial to marine sedimentation. This commenced in response to the early stages of rifting and formation of the Proto-Atlantic (Williams *et al.*, 1974b). Carbonate sedimentation was established in the Middle Cambrian and maintained into the Lower Ordovician. Carbonate sedimentation occurred platform wide in three megacycles related to transgression and regression (see Table 1). Transgression produced mound facies of large stromatolites and bioturbated lime muds, consistent with a subtidal shelf environment. Regression produced very shallow shelf conditions with numerous shoaling upward carbonate sequences deposited in unrestricted, near normal marine to restricted, hypersaline peritidal conditions.

The general lithologies and environmental interpretation of the various rock units for the west and east side of the northern part of the Northern Peninsula are summarized in Table 1. Variation within the Roddickton area are also included and a number of conclusions become apparent.

1) A marked lithological change occurs in the Cambrian strata between the western side of the peninsula and the Roddickton area. This change coincides with the area of the Hatters Pond and Shoal Pond Faults.

2) There is also a distinct lithological change in the upper unit of the Labrador Group in the Roddickton area, coinciding with the Saltwater Cloud Pond Fault.

3) Lithological variations occur in the Lower Ordovician across the Shoal Pond Fault. This includes a reduction of the thickness of dolomitized strata in the basal black dolomite and limestone formation (Watts Bight formation) of the St. George Group, a thinner development of the "unnamed formation" in the vicinity of and south of the fault, and a predominance of lime muds southeast of the fault.

4) Facies in both Cambrian and Lower Ordovician suggest that marginal shelf conditions existed in the map area. In the Cambrian, oolite sand shoals were important in the upper formation of the Labrador Group, and to a lesser extent in the Middle Cambrian limestone formation. Widespread evidence of postdeposi-

			WEST SIDE OF NORTHERN PENINSULA (after Knight 1977, 1978; Schuchert & Dunbar, 1934)			RODDICKTON MAP AREA N.W.			S.E.
			FORMATION	LITHOLOGY	ENVIRONMENT	LITHOLOGY	ENVIRONMENT	LITHOLOGY	ENVIRONMENT
LOWER ORDOVICIAN		ST GEORGE GROUP	SILICEOUS DOLOMITE	Dolostones, dolomitic shales, sand grains.	*Sabkha* HATTERS	POND FAULT	Not So Far Observed		
			CATOCHE	Bioturbated, fossiliferous micrite lenses of calcarenite, minor stromatolite mounds.	*Subtidal shelf; lime mud and lenticular sands, minor organic mounds* ◄—— MAJOR	Bioturbated, fossiliferous micrite, lenticular calcarenite, stromatolite-sponge mounds with calcarenite. TRANSGRESSION	*Subtidal shelf; burrowed lime muds and sands.*	SHOAL POND FAULT Bioturbated biomicrite, mud banks, scouring.	*Deeper water outer shelf; lime muds*
			"UNNAMED"	Cycles of biomicritic and stromatolitic limestone and laminated dolomitic limestone. 'Pebble Bed' Stromatolitic limestone, biomicritic, & stratified micritic limestone, cherty dolostone, pseudobreccia. Breccia	*Shallow shelf; shallowing upward peritidal cycles* *Disconformity, exposure & solution* *Unrestricted normal marine shallow shelf; intertidal and some subtidal & supratidal.* *Possible Disconformity*	Cycles of biomicritic & stromatolitic limestone & laminated dolomitic limestone. Erosion Stromatolite-calcarenite Biomicritic and stromatolitic limestone, dolostone Breccia	*Shallow shelf; shallowing upward peritidal cycles.* *High energy stromatolite-carbonate sand bank.* *Unrestricted normal marine shallow shelf; intertidal & subtidal with minor supratidal.* *Possible Disconformity*	Cycles of biomicritic limestone & laminated dolomitic limestone. Presence of disconformity not apparent Bioturbated micritic limestone. No apparent break	*Shallowing upward shallow shelf carbonates.* *Subtidal shelf*
			WATTS BIGHT	Black cherty crystalline dolomite, stromatolite mounds & bioturbated dolomite; minor limestone.	*Subtidal shelf; stromatolite banks and burrowed lime muds (now dolomitized)* ◄—— MAJOR	Black, cherty, crystalline dolomite, stromatolite mounds & bioturbated dolomite. TRANSGRESSION	*Subtidal shelf; stromatolite banks & burrowed lime muds (now dolomitized)*	Bioturbated micritic limestone & some stromatolite mounds. Basal black stromatolitic & bioturbated dolomite. Thinning southwards.	*Subtidal shelf; lime muds & some large stromatolite mounds.*
CAMBRIAN	UPPER	CAMBRIAN CARBONATES	DOLOMITE Cherty dolomite member	Dark gray, stromatolitic and mottled, shaly dolomite and dolostone.	*Restricted hypersaline predominantly intertidal carbonates throughout formation*	Consistent Throughout Northern Peninsula			
			Upper dolostone member	Bedded dolostones, minor dolarenite & stromatolites.		Dolostones, dolomitic shales, stromatolites common, dolarenite, mottled shaly dolomite, breccia.	*Predominantly, restricted hypersaline shallow shelf, shoaling upward sequences of intertidal supratidal shoreline and carbonate flats*	Lithologies consistent throughout the area. SALT WATER CLOUD POND FAULT	
			Stromatolite member	Stromatolite, oolite-intraclastic dolarenite, dolostone.	*Intertidal stromatolite banks & sand shoals*				
			Lower dolostone member	Bedded dolostone and shale, minor small stromatolite.					
	MIDDLE		MICRITE	Bioturbated micritic & biomicritic limestone, argilleous micrite, dolomitised at base and top, shale.	*Subtidal shelf.* *Burrowed lime muds* ◄—— MAJOR	Bioturbated, micritic and argilleous micritic limestone. Oolitic calcarenite, stromatolitic mounds; slump beds common. TRANSGRESSION	*Subtidal shelf; lime muds, oolite sand shoals & stromatolitic banks.* *Tectonically unstable.*	Bioturbated, micritic limestone oolitic calcarenite & oncolites. Thins to stratified limestone eastward.	*Subtidal shelf; lime muds & oolite sands & shoals.* *Thin slope limestones.*
	LOWER	LABRADOR GROUP	HAWKE BAY	Well washed quartz sandstones, minor shale, muddy sandstones.	*Shallow subtidal; high energy inner shelf sand flat.*	Quartz sandstones, sandy dolomites, dolomitic sandstones, shales. Some mudstone, minor oolite.	*Mostly sheltered carbonate flat and sandy shoreline*	Oolitic calcarenites & stromatolite, mudstone & minor quartz sandstones. Abundant soft sediment deformation.	*High energy oolite sand shoals & islands. Low energy, outer shelf muds.* *Tectonically unstable.*
			FORTEAU	Fossiliferous shales, muddy siltstones, minor carbonate & siliciclastic sands, archeocyphid reefs. Fossiliferous black shale in middle of unit.	*Shallow subtidal; low energy to some high energy muddy, shelf.* *Stable, quiet, restricted deposition*	Calcareous siltstone, shale, nodular limestone, minor limestone. Some oolitic limestone & thin quartz sandstone near top. Basal limestone unit; black shale & thin limestone in middle of formation.	*Outer low energy shelf; muddy siltstones with some shallow lime sand shoals* *Some tectonic instability* *Stable, quiet water stagnant basin conditions*		
			BRADORE	Red and cream arkosic sandstone.		Red pebbly arkose & haematitic sandstones.	*Alluvial fan, pebbly-sandy braided stream*		

TABLE 1 Summary of lithologies and environments of Roddickton map area and comparison and correlation with rock units of the western side of the Northern Peninsula. Double lines represent faults believed to be active or marking zones of lithological change during deposition.

tional deformation in both of these units suggest periodically unstable shelf margin conditions (Wilson, 1975).

In the Lower Ordovician, a high energy, stromatolite - carbonate sand complex which was subjected to erosion and karstification, suggests an elevated shelf area occurred in the "unnamed formation" just northwest of the Shoal Pond Fault. High energy shoal conditions were maintained in the overlying Catoche Formation with the deposition of stromatolite - sponge mounds and carbonate sands. Also important is the thicker development of stromatolite mounds in and complete dolomitization of the basal Ordovician (Watts Bight formation) just northwest of the same fault. Such stromatolite mound and carbonate sand facies are also common at shelf margins (Wilson, 1975).

5) Comparison of the autochthonous platform sequence in the western part of the map area to that in the thrust slices to the east indicates:
a) the thick sequence of the upper unit of the Labrador Group and the overlying Middle Cambrian limestone rapidly thins when traced eastward into thrust slice 3 and
b) platform margin carbonates of the west change in character to thin shales and thinly stratified limestones with minor coarser beds, typical of toe of slope or foreslope deposits seaward of a shelf (Wilson, 1975) to the east. This suggests that the shelf edge at this time sloped away quite rapidly oceanward.

6) Upper Cambrian dolomites change their lithological character across the Hatters Pond Fault and form the most extensive and easterly preserved carbonate unit in the succession. The unit occurs in thrust slice 3 and has been reported further east in a "carbonate window" within the Hare Bay Klippe (Smyth, personal communication, 1979) along the Croque highway. Such oceanward outbuilding of the platform commonly occurs in a regressive event with rapid sedimentation (Wilson, 1975).

Development of platform

Preserved Cambro-Ordovician strata suggest the Roddickton map area, marked the eastern margin of the ancient Lower Paleozoic platform. North and northeast trending faults, along which the basement probably floundered were important controls in the location of the platform margin and appear to have been active periodically throughout the Cambrian and Lower Ordovician. West of the Hatters Pond Fault, generally stable, flat, platformal conditions existed in Cambro-Ordovician times with facies extending over very wide areas. In the Roddickton area, facies such as oolite and carbonate sand shoals and stromatolite mounds are narrow in distribution, typical of the shelf margin. Slumping and soft sediment deformation especially in the upper Lower and Middle Cambrian strata suggest this margin was unstable during its history. The rubbly limestone breccias in the Catoche Formation near the Hatters Pond Fault may also reflect the response of thinly bedded limestones to similar Ordovician instability.

The position of the shelf margin was never static. In the upper unit of the Labrador Group and in the Middle Cambrian, the margin occurred in the vicinity of Chimney Arm with a fairly rapid drop off to thin slope deposits. A narrow oolite sand marginal facies marked the margin which, when exposed, formed islands and created a barrier. Carbonate mudflats developed on the sheltered lee of the islands. A transgressive event occurred in the Middle Cambrian but did not effect the position of the shelf margin. It is likely that the Hatters Pond and Saltwater Cloud Pond faults were active until this time. Regression occurred by the Upper Cambrian as sedimentation outstripped subsidence of the shelf and a thick sequence of restricted, carbonate flat (sabkha?) and shoreline sediments were deposited. The margin at this time migrated eastwards at least 8-12 km as the peritidal dolomites prograded over the old Middle Cambrian shelf edge and across the thin foreslope deposits. To do this, sedimentation must have at first outstripped subsidence and was later in approximate equilibrium. Although the platform was thus considerably enlarged in the Upper Cambrian, a change of sedimentation style does occur from stable platform in the west, across the Hatters Pond-Shoal Pond fault zone to that deposited in the Roddickton area. However, no evidence of platform instability due to fault movements has been noted for this time period.

A major and fairly rapid transgression initiated Lower Ordovician sedimentation. Evidence of stromatolite banks and high energy carbonate sands lying just northwest of the Shoal Pond fault zone suggest that the shelf margin shifted westward to the vicinity of this area. However, the wide foundation afforded by the Upper Cambrian dolomites allowed thick deposits of lime muds to be deposited east of this positive area and to form an outer shelf environment. Sedimentation in the map area within the Lower Ordovician can be correlated with that farther to the west on the stable platform. It formed in response to a transgression-regression megacycle (Watts Bight - unnamed formations) followed by later major transgression in the Catoche Formation. However, the lithologies characteristic of the basal trangressive part of the St. George Group (Watts Bight formation) and the overlying regressive stage (unnamed formation) that form the first Lower Ordovician megacycle are generally much thinner and more difficult to trace eastwards in the map area than on the stable western shelf area. This might be explained by a change of slope *i.e.* deeper conditions, southeast of the Shoal Pond Fault which caused a reduction in the effects of the regressive event. It may be that the northeast trending faults were active again in the Lower Ordovician and influenced the transgression.

STRUCTURE AND METAMORPHISM

The rocks of the Cambro-Ordovician platform in the Roddickton area have been variably deformed. Intensity of deformation increases eastwards and southwards. Authochthonous platformal rocks are only gently tilted in the north and west of the area north of the Saltwater Cloud Pond Fault. They become increasingly deformed however to the south of the fault. A number of important north trending thrust faults (figures 2 and 4) occur in the eastern half of the area. These repeat the stratigraphy in a number of imbricate thrust slices. Northeast trending high angle faults crosscut the stratigraphy and thrust slices.

Three phases of deformation occurred in the area. The earliest phase is probably related to westward emplacement of the Hare Bay Allochthon. Thrust faults and slices formed in the platform sequence at this time. Mylonitised limestones, foliated marbles, breccias and zones of intense deformation mark the thrusts. The thrusting can possibly be divided into two events. The earliest event emplaced thrust slices 1 and 2 along low angle thrust faults so that Cambrian strata overrode Lower Ordovician strata. This was followed by a later somewhat steeper thrusting or reverse faulting in which Ordovician strata (slice 3) overrode Cambrian strata of thrust slice 2. Tectonic wedges of green coloured sandstones (unit 8a) of the Maiden Point Formation (Smyth, 1973) occur along the sole of thrust slice 3 and suggest this thrusting post dates Middle Ordovician emplacement of the Hare Bay Allochthon. Northwestward facing recumbent folding in limestones and tight isoclinal, vertical to slightly westward facing folds formed in strata adjacent to the thrust faults.

The second deformation in the area is characterized by steepening and folding of the D_1 thrusts as at Bide Head and refolding of the steep isoclinal folds into type 1 interference fold patterns (Ramsey, 1967). Folds are mostly upright to northwest facing, assymmetrical, open folds, which plunge northeast between 7° and 35°. A well developed axial planar cleavage is developed in the limestones and is the pervasive cleavage seen throughout the area.

A flat to gently southeast dipping, widely spaced crenulation cleavage, locally transposing the S_2 cleavage in shale units of thrust slice 2, represents the third phase of deformation. Its proximity to the thrust faults and flatlying attitude suggests it is related to late locallized movements along the D_1 thrusts.

High angle, northeast trending faults displace the stratigraphy and thrust faults in the area. The late faults are usually clean, sharp breaks with only minor brecciation although they are parallelled by numerous fractures and minor faults. Sinistral strike slip motion has occurred along many of these faults particularly in the south of the area. Drag folds with steep plunges and some overturning accompany the strike slip movement. The faults in the north of the area are normal or reverse faults which downthrow to the northwest.

A north trending, high angle, normal fault, the Hatters Pond Fault downthrows Cambrian and Lower Ordovician strata between 400-500 m against the Precambrian granites and Lower Cambrian siliclastics. The carbonates are brecciated for several metres close to the fault. This fault forms the eastward limit of Cambrian lithofacies and stratigraphy that is found across the northern tip and western side of the Northern Peninsula. This suggests it probably was an early basement fault that influenced sedimentation during the formation of the Lower Palaeozoic western platform. The fault was later reactivated following the Taconic and Acadian tectonic events.

The sedimentary rocks close to the Hare Bay Allochthon are metamorphosed to greenschist facies. Chlorite is common in deformed shales and along small thrust faults. Recrystallization of both limestone and dolomite occurs, the dark colored limestones turning usually to white, foliated marbles and the dolomites recrystallizing to white crystalline dolomite marbles. Chert is usually bleached in the more intensely deformed area.

ECONOMIC GEOLOGY

Minor zinc mineralization is known in the map area (Sauerbrei, 1964; Siragusa, 1966; Phillips Management, 1975), but none of their showings were located during the mapping. No new showings were discovered.

The previously known mineralization occurs in both Cambrian and Lower Ordovician strata, and this is concentrated along the Upper Cambrian - Lower Ordovician boundary and at the disconformity within the Lower Ordovician.

A number of soil geochemical zinc anomalies were located on the Bide Head Peninsula (Sauerbrei, 1964; Siraggusa, 196). These occur mostly just below the upper contact of the cherty dolomite member of the Upper Cambrian dolomite formation in thrust slice 1. Traces of sphalerite and pyrite occur, and in the best showings chip samples analysed up to 4.79% Zn, 0.15% Pb and 19.20 g/t Ag. At least one geochemical anomaly is associated with a northeast trending fault but no mineralization was found.

Zinc mineralization is concentrated in two areas north of Roddickton. A cluster of showings of trace to minor amounts of sphalerite and pyrite occur just northwest of Montgomery Pond and straddle the Upper Cambrian - Lower Ordovician boundary (Phillips Management, 1975). A significant showing of 15.4% Zn and minor pyrite is said to occur on a peninsula on the coast of Northeast Arm. This showing is, however, not located on maps (Phillips Management, 1975) but descriptions suggest it probably occurs in strata associated with the same geological units as the Montgomery Pond showings.

A second zinc showing was located by Phillips Management (1975) near the Underground Hole on Beaver Brook. The showing of greenish-yellow sphalerite occurs in the strata beneath the erosional disconformity (Figure 3). The sphalerite occurs in the dikes of vuggy dolomite that replace the stromatolitic limestone. Grades of 1-3% zinc were estimated. However, no sphalerite was located when the showing was examined, although pale green-yellow, cubic fluorite crystals are disseminated in the dolomite.

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GEOLOGY OF CARBONIFEROUS STRATA IN THE CORMACK (12H/6) AND SILVER MOUNTAIN (12H/11) MAP AREAS

by

Richard S. Hyde and Michael J. Ware*

INTRODUCTION

Discoveries of uranium-rich sandstone fragments in tills by Westfield Minerals in 1978 prompted mapping of Carboniferous strata in the Cormack (12H/6) and Silver Mountain (12H/11) areas in 1979, as part of an ongoing project to map the Deer Lake Basin on a 1:50,000 scale. Carboniferous strata in the map area unconformably overlie Late Precambrian to Devonian crystalline and metasedimentary rocks, but locally, fault contacts are present. These pre-Carboniferous rocks were briefly examined near the contact with the main body of Carboniferous strata. The map area is part of a Carboniferous graben-like trough termed the Deer Lake Basin. Carboniferous rocks of the Deer Lake Basin consist of two groups: (1) the lower Mississippian Anguille Group, and (2) the upper Mississippian to lower Pennsylvanian Deer Lake Group. Popper (1970) and Hyde (1979) have informally subdivided the Anguille Group. Subdivision of the Deer Lake Group (Belt, 1969) is, in ascending order: (1) North Brook Formation; (2) Rocky Brook Formation; (3) Humber Falls Formation; and (4) Howley Beds.

Important results include:

(1) Discovery of radioactive anomalies in the Deer Lake Group and in Cambrian metasandstones.

(2) Delineation of an outlier of the North Brook Formation consisting of lithologies new to this formation.

(3) Extending the known distribution of the North Brook Formation in a northeastward direction along the southeastern part of Birchy Ridge.

(4) Recognition of the Rocky Brook Formation along Boot and Big Falls Brooks. This unit is not shown at these localities on previously published maps.

(5) The absence of a regional fold closure, as is usually shown on older maps, involving the Deer Lake Group in the northern part of the Cormack area.

(6) Presence of a synclinal fold closure southeast of Adies Pond involving the Humber Falls Formation, and a new distribution of the Rocky Brook and Humber Falls Formations in the southern part of 12H/6 area.

STRATIGRAPHY

Anguille Group (Map Unit 6)

Hyde (1979) subdivided the Anguille Group into four mappable units, which occur in two fault blocks called the Glide Mountain and Birchy Ridge - White Bay blocks. In the Cormack area, the latter structural block is present and is mainly underlain by dark gray to black fine grained sandstones, siltstones, and mudstones. These rocks contain abundant detrital white mica and carbonaceous material. Sedimentary structures include cross-lamination, climbing ripple lamination, convoluted bedding and slumping. These fine grained beds are intercalated thickly-bedded, medium to coarse grained, micaceous, light gray sandstones that have erosive

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LEGEND

CARBONIFEROUS

DEER LAKE GROUP

10 Howley Beds: Brown and yellow-brown, coarse grained sandstone and pebble conglomerate.

9 Humber Falls Formation: Pink, orange, red and gray, predominantly medium to coarse grained sandstone; pink and gray pebble conglomerate; red and gray silstone.

8 Rocky Brook Formation: Calcareous red and gray silstone and mudstone, limestone (including algal, oolitic and pisolitic types); very fine to fine grained red and gray sandstone; oil shale.

7 North Brook Formation: 7a, Red and gray medium to coarse grained sandstone; red and gray, pebble to boulder conglomerate; gray and pink limestone; red siltstone and mudstone; 7b, pebble to boulder limestone conglomerate set in calcareous matrix; vuggy, gray and yellow microsparic limestone.

ANGUILLE GROUP

6 Gray, micaceous, medium to coarse grained sandstone; dark gray to black, micaceous fine to very fine grained sandstone, siltstone, and mudstone; light gray pebble conglomerate; gray, micritic limestone.

DEVONIAN

5 Gales Brook Stock: Gray and white granitoid rock, minor gabbro.

SILURIAN

4 4a, Felsic volcanic rocks; 4b, mafic volcanic rocks.

ORDOVICIAN OR OLDER

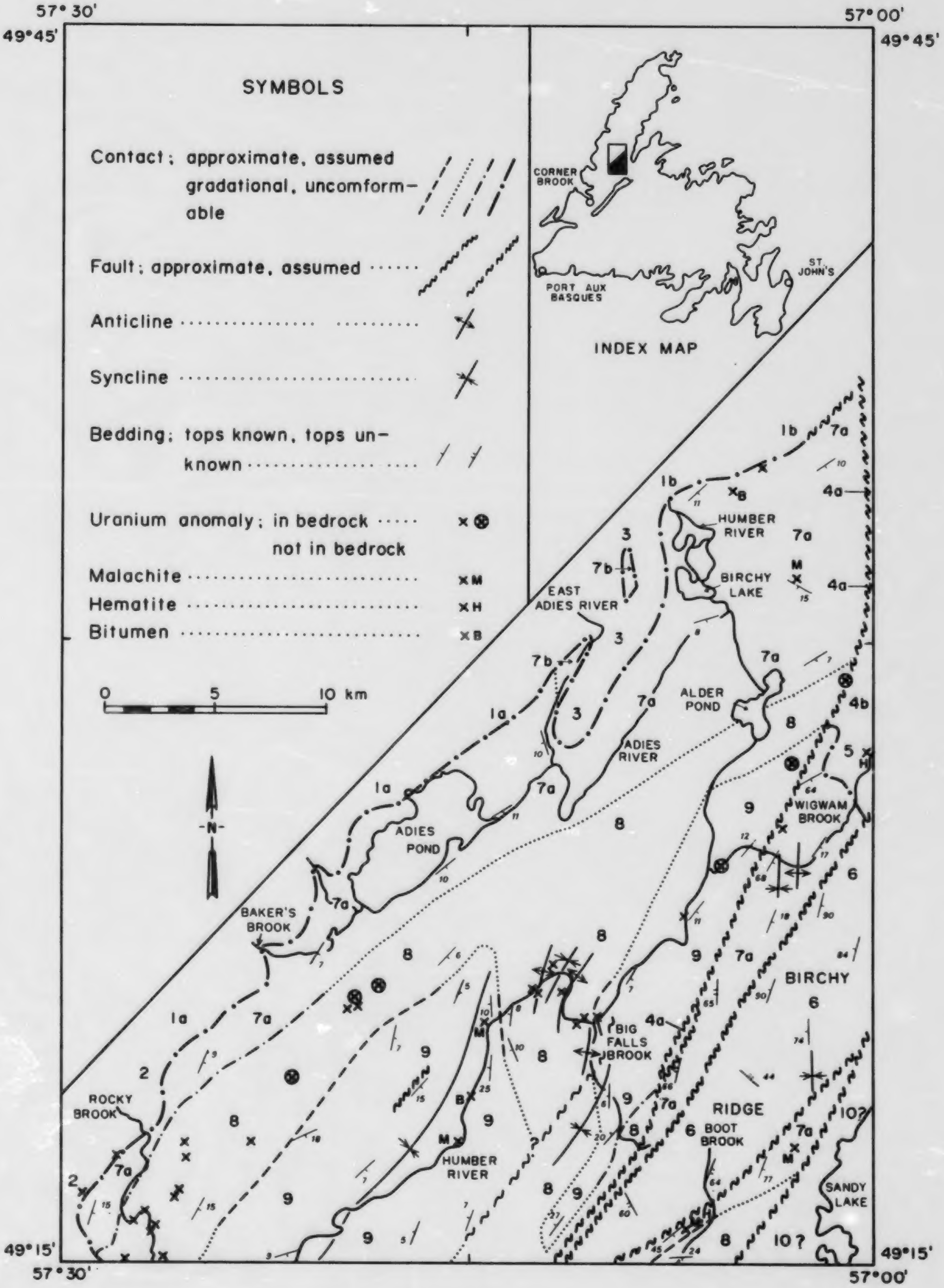
3 Marble and recrystallized limestone

CAMBRIAN

2 Quartz-mica schist, chlorite schist, marble, quartzite.

PRECAMBRIAN

1 1a, Granitoid and granitoid gneiss; 1b, Gabbro and gabbroic gneiss.


57° 30'
49°45'
57° 00'
49° 45'
SYMBOLS
Contact; approximate, assumed gradational, uncomformable
Fault; approximate, assumed
Anticline
Syncline
Bedding; tops known, tops unknown
Uranium anomaly; in bedrock
not in bedrock
Malachite
Hematite
Bitumen
×M
×H
×B
0
5
10 km
N
CORNER BROOK
PORT AUX BASQUES
ST. JOHN'S
INDEX MAP
1b
7a
4a
HUMBER RIVER
BIRCHY LAKE
3
7b
EAST ADIES RIVER
1a
ALDER POND
ADIES RIVER
4b
5
H
8
9
WIGWAM BROOK
6
ADIES POND
BAKER'S BROOK
BIRCHY
BIG FALLS BROOK
2
ROCKY BROOK
RIDGE
BOOT BROOK
10?
SANDY LAKE
M
B
49°15'
57°30'
57°00'

bases and are cross-stratified and parallel laminated. Pebble conglomerates with clasts dominated by vein quartz and felsic volcanics are also present in the Anguille Group. Gray, microcrystalline limestones occur at one locality, and are interbedded with fine grained sandstone and siltstone.

It is very difficult to estimate a thickness for this unit due to folding and faulting, but it is probably at least 1000 m. Based on observations elsewhere in the Deer Lake Basin, Hyde (1979) interpreted this unit as the product of a lacustrine delta with a network of distributary channels. None of the observations in the Cormack map area alter this interpretation.

Deer Lake Group

North Brook Formation (Map Units 7a, 7b)

In the map area, two units in the North Brook Formation are distinguished. The first consists of red and gray, medium to very coarse grained sandstones, and pebble to boulder conglomerates (Unit 7a). Also present are pink and gray limestones and red and gray, very fine to fine grained sandstones, siltstones and mudstones. Gray beds are restricted to the area southwest of Baker's Brook on the west side of the basin and within fault slices on both sides of Birchy Ridge.

Red sandstones are calcareous and commonly contain green and gray reduction spots. The sandstones contain abundant large-scale cross-stratification (mainly trough type) and channels. Abundant plant fossils were observed near and along Wigwam Brook. On the east side of Birchy Ridge, gray sandstones and red siltstones are arranged in fining-upward sequences.

Conglomerates are more abundant towards the base of the North Brook Formation. Close to the unconformable contact with pre-Carboniferous rocks, boulder conglomerates are commonly present with clasts greater than 1 m in size. Typically, beds are thick and show no internal stratification. Clasts are poorly sorted. Conglomerates at higher stratigraphic levels have smaller clasts, are more thinly bedded and form lenses within predominantly sandy rocks. Clast rock types reflect local derivation from the underlying basement rock. Conglomerates along Baker's Brook and some other streams contain calcified and silicified wood fragments.

On the west side of the basin, pink and cream-colored microcrystalline limestones form beds up to 20 cm thick. In some areas, calcite has extensively replaced quartz to form sandy limestones. Within the fault slice on the west side of Birchy Ridge, gray, sparry to micritic limestones contain pisolites and algal (?) laminations.

The second unit in the North Brook Formation (Unit 7b) contains two lithologies. The first type is oligomictic, pebble to boulder carbonate conglomerate set in a limestone matrix. This is interbedded with sparites and micrites that are characterized by completely and partially filled vugs, laminations, oolites, and pisolites.

Deposition of map unit 7a of the North Brook Formation occurred on alluvial fans close to the basin margin and within braided river conditions farther away from the basin margin. Near the center of the basin (*e.g.* east side of Brichy Ridge) deposition occured in meandering rivers. Conglomerates in unit 7b developed as mass flow deposits adjacent to pre-Carboniferous carbonate highlands. Interbedded limestones are interpreted to be mainly carbonate soils, which developed during inactive periods of gravel deposition.

Paleocurrents from the west side of the basin show paleoflow directed toward the southeast and east. A maximum thickness of 500 m is assigned to the North Brook Formation in the map area.

Rocky Brook Formation (Map Unit 8)

The Rocky Brook Formation gradationally overlies the North Brook Formation, and near its base consists of red and gray, fine to very fine grained sandstones, red, gray and green siltstones and mudstones, and oolitic and microcrystalline limestones. Siliciclastic lithologies tend to be calcareous. Sedimentary structures are dominated by cross-lamination and dessication cracks.

Red beds are absent from the upper part of the formation. The uppermost beds of the Rocky Brook Formation are well exposed along the Humber River, and contain calcareous gray siltstones and mudstones, gray microcrystalline limestones, algal, oolitic and pisolitic limestones, and oil shales. Siltstones and mudstones contain large carbonate concretions (tens of centimetres in size) and pyrite nodules. One type of limestone is gray and massive, forming beds 20-40 cm thick. These limestones exhibit spheroidal weathering and are cut by numerous veinlets of calcite that in some places brecciate the rock. Another type of limestone contains oolites and pisolites in beds and 1-5 cm thick. These limestones alternate with laminated, dark brown oil shale. Disseminated fish remains are associated with the oolite-pisolite layers. Stromatolitic limestones are also associated with oolitic layers.

Red sandstones and siltstones near the base of the Rocky Brook Formation are interpreted as fluvial in origin. Most of the Rocky Brook Formation records lacustrine deposition for reasons cited elsewhere (Hyde, 1979). The maximum thickness of the Rocky Brook Formation in the map area is estimated to be 550 m. Drilling for natural gas in the map area in the 1950's revealed about 415 m of Rocky Brook strata (Fleming, 1970).

Humber Falls Formation (Map Unit 9)

The Humber Falls Formation sharply overlies the Rocky Brook Formation and based on drill hole information provided by Westfield Minerals is shown here to crop out in two separate areas, unlike previous geological maps of the area. Orange, pink, gray, and nearly white arkosic sandstones dominate the Humber Falls Formation. The sandstones are mostly medium to very coarse grained, and kaolinized feldspar is a characteristic feature. Fine grained sandstones are also present and tend to be redder and more calcareous than the coarser grained sandstones. Pebble conglomerates are interlensed with the sandstones, and contain a wide variety of clast rock types. The most abundant are felsic volcanics, quartz, recrystallized quartz and granitoid clasts. Red and gray siltstones also occur in the Humber Falls Formation, with beds up to 1.5 m in thickness.

Large scale trough and planar cross-stratified sets are common in sandstones and also occur in conglomerates. Additional current produced structures are elongated scours and channels, reactivation surfaces, preserved megaripples, parallel lamination, and parting lineation. Other features noted are gray and green reduction zones, calcareous nodules, mudcracks, and fossil logs.

The Humber Falls Formation is interpreted to be a fluvial deposit in which the river system was dominantly braided. Paleoflow reconstruction shows that currents were directed to the south in the northeastern outcrop area but in the southwestern outcrop area, exposures along the Humber River yielded paleocurrents flowing in a generally westward direction. Over much of the Deer Lake Basin, the Humber Falls Formation forms the top of the Deer Lake Group, and much of the original sediment has been eroded. As a maximum, it is estimated that 100 m has been preserved. A hole drilled for natural gas in th 1950's penetrated about 33 m of the Humber Falls Formation (Fleming, 1970).

Howley Beds

The Howley Beds of dominantly Pennsylvanian age are interpreted to underlie flat ground along and near the western shoreline of Sandy Lake. No outcrops were observed in this area, but medium to coarse grained, poorly indurated, gray and buff sandstones and pebble conglomerates are present a few kilometres to the southwest. These beds strike northeasterly, and probably extend into the present area. Lithologically, these rocks best match the description of the Howley Beds in Belt (1969), and are therefore assigned to this unit. Baird (1959) also showed the Howley Beds underlying this region.

STRUCTURAL GEOLOGY

Folding

Rocks in the Anguille Group are tightly folded. Dips of beds are usually greater than 45 degrees and vertical dips are not uncommon. The orientation of fold axes are at small angles to the orientation of major faults, in accord with observations made elsewhere in the Deer Lake Basin (Hyde, 1979). In contrast to folding in the Anguille Group, rocks in the Deer Lake Group assume steep dips and tight folds only in the vicinity of faults. Away from faults, folds are present but are only gentle warpings. The prominent anticlinorium which brings the Rocky Brook Formation to the surface west of Birchy Ridge, is no longer assumed to be doubly plunging within the map area. Parasitic minor anticlines and synclines are related to this major structure. West of this structure, a prominent syncline occurs within the Humber Falls Formation. This is part of a large doubly-plunging synclinal fold in the Deer Lake Group. The southwestern fold nose occurs outside the area mapped. Other maps for this region (Werner, 1955; Baird, 1959) show a fold closure southeast of Alder Pond. However, from strike directions in the North Brook and Humber Falls Formations and from drill hole information provided by mining companies (Westfield Minerals and Northgate Exploration), it appears that units of the Deer Lake Group strike continuously to the northeast and are truncated by a major fault bordering pre-Carboniferous volcanic rocks further east.

Faulting

As shown on the map, all Carboniferous units are affected by faulting. Faults have fairly straight surface traces, implying that the faults dip steeply. Rarely is it possible to determine the dip of a fault plane, hence the type of latest fault movement is difficult to show. A fault which forms the eastern boundary of a slice of pre-Carboniferous volcanic rocks on the west side of Brichy Ridge dips steeply (79 degrees) to the northwest. Hence, the latest movement on this fault at this locality was reverse. On Big Falls Brook, the fault between the Anguille Group and the North Brook Formation appears to dip steeply to the southeast (69o), which would indicate reverse movements. However, if this fault is traced to the northeast, granite of probable Devonian age is faulted against the Anguille Group, and the fault must be normal at this point, assuming the dip direction of the fault plane is still to the southeast. Thus, the latest movement on this fault seems to have been a scissors-type. This kind of motion has been inferred by Popper (1970) for the continuation of this fault to the southwest.

The latest movement of these major faults is demonstrably dip slip or oblique slip, but it has been argued elsewhere (Hyde, 1979) that earlier movements on the faults were dominantly strike-slip. One new finding this year is the presence of sandstone pebbles similar to the Anguille Group in the North Brook Formation along Big Falls Brook. If these pebbles were derived from the Anguille Group, it may be an indication that dip-slip and/or oblique-slip movements had started, at least locally, prior to deposition of the North Brook Formation.

Small faults with displacements of less than 1 m are present within the Rocky Brook Formation along the Humber River. These faults cause the dip of the beds to exceed 25° on a local scale. Elongated bogs with straight boundaries may be geomorphic expressions of faults and, if so, there are numerous northeasterly trending faults which are not readily apparent because of poor exposure.

ECONOMIC GEOLOGY

Fifty-one radioactive anomalies were recorded during the field season using a BGS-IL total count scintillometer. Some of these are shown on the accompanying map. It is assumed that anomalies in Carboniferous rocks are due to uranium.

Pre-Carboniferous Basement Rocks

Two anomalies were recorded in Cambrian metasandstones in the southwestern part of the map area, the larger being 4 x back-ground. An anomaly (2 x background) was recorded from a gneissic boulder along the East Adies River.

North Brook Formation

Three anomalies were discovered in the map unit 7a of the North Brook Formation, one of which is in a limestone. This limestone is a thin (20 cm) breccia bed which rests unconformaly on Cambrian metasandstones. This anomaly was the strongest recorded in the North Brook Formation (3.5 x background).

Rocky Brook Formation

Forty-one anomalies were recorded in the Rocky Brook Formation, and these occur in the following lithologies: (1) gray, calcareous siltstone and mudstone (16 occurrences); (2) gray, microcrystalline limestone with calcite veinlets (11 occurrences); (3) thinly bedded oolitic and pisolitic limestone interbedded with oil shale and gray mudstone (4 occurrences); (4) gray, microcrystalline limestone with sparry vug fill (3 occurrences); (5) brownish-red, fine grained sandstone and siltstone (2 occurrences); and (6) oil shale (1 occurrence). Three anomalies occur in areas lacking outcrop, but it is assumed that the underlying bedrock is the Rocky Brook Formation. The anomalies in the Rocky Brook Formation are usually confined to a single bed, average about 30 cm thick, and have been traced laterally for up to 75 m. Most of the anomalies are 2-4 times background. The strongest anomaly occurred on Rocky Brook, and yielded 1700 total counts per second (11 x background).

Humber Falls Formation

The Humber Falls Formation seems to have the best potential for economic uranium deposits, judging from discoveries made in 1978 by Westfield Minerals (Northern Miner, Nov. 23, 1978). One anomaly was found in outcrop during the course of our mapping, and yielded 600 total counts per second (12 x background). Other anomalies were found in till cobbles near Westfield trenches.

Other Findings

Malachite staining was observed at three places in the North Brook Formation and twice in the Humber Falls Formation. Hematite was observed in the North Brook Formation as a coating on bedding planes. Small amounts of hematite were also observed in a granite of presumed Devonian age. Barite occurs as a vein-filling mineral in carbonate concretions in the uppermost beds of the Rocky Brook Formation. A solid bituminous-like substance was also found in sandstones of the North Brook and Humber Falls Formations.

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BADGER MAP AREA (12A/16), NEWFOUNDLAND

by

B.F. Kean and N.R. Jayasinghe

INTRODUCTION

Mapping of the Badger map area (12A/16) was completed during the 1979 field season. The area was previously mapped on a scale of 1:250,000 by the Geological Survey of Canada (Williams, 1970). The geology of the area was compiled on unpublished, 1:50,000 scale maps by F. Anderson of the Geological Survey of Canada. Parts of the area have been mapped by mining companies (ASARCO, NORANDA).

The map area is divided into two parts by the northeast flowing Exploits River. The area south of the river can be reached by private logging roads from Grand Falls. The area north of the river is accessible via the Buchans highway (Route 50) that branches off the Trans Canada Highway at Badger. However, the northwest corner of the map area is accessible only by helicopter.

Bedrock exposure is generally poor. The area has an extensive till and glacial gravel cover. The predominant direction of ice movement was northeasterly.

General Geology

The map area is predominantly underlain by sedimentary rocks of the fossil dated pre-Middle Ordovician Victoria Lake Group, and by younger sedimentary rocks. The Hungry Mountain Complex, Buchans Group and Skull Hill Granite occupy the northern part of the map area. The Hungry Mountain Complex overthrust the Buchans Group and both have been intruded by the Skull Hill Granite. The relationship between the Buchans Group and the sedimentary rocks (unit 5) to the south is not clear, however it has been inferred to be a fault by Williams (1970) and a conformable contact by Anderson (1972). Considering (a) the conformable contacts between the Victoria Lake Group, the Harbour Round Formation and overlying lithologies that resemble the Buchans Group (Kean, 1977a) and (b) regional stratigraphic correlations (Kean, 1977b), the Buchans Group is interpreted to be younger than the sedimentary rocks of unit 5 in the map area. However, the contact in the map area is interpreted to be a fault by the authors.

DESCRIPTIONS OF ROCK UNITS

Hungry Mountain Complex (Unit 1)

The Hungry Mountain Complex (Thurlow, 1975) occupies the northeastern corner of the map area. The complex was divided into an eastern and a western belt by Kean (1979) and only the eastern belt occurs within the present map area. It consists of two phases; an older gabbroic-dioritic phase (unit 1a) and a younger granodioriti-granite phase (unit 1b). The gabbro-diorite phase is fine to coarse grained equigranular and consists of plagioclase, pyroxene and hornblende. In places leucodiorite intrudes the gabbro and xenoliths of gabbro, diorite and diabase are common. Some of the gabbro xenoliths have been deformed prior to incorporation.

The gabbro-diorite phase is for the most part undeformed, but in places it contains a distinct fabric. An alignment of amphibole crystals seen locally may be related to the emplacement of the complex.

The granodiorite-granite phase consists essentially of medium to coarse grained granodiorite and minor granite.

DEVONIAN

11 Skull Hill granite: 11a, diorite, gabbro and hybrid diorite; 11b, fine grained, red syenite, quartz syenite and granite.

MIDDLE ORDOVICIAN AND YOUNGER

10 Cripple Back Lake quartz monzonite: medium grained, quartz monzonite and minor unseparated basic phases.

9 Gabbro

BUCHANS GROUP (Units 6-8)

8 Silicic and intermediate volcanic rocks undivided; 8a, dacite and rhyolite breccia and tuff, quartz-feldspar porphyry and crystal tuff, minor massive flows; 8b, feldspar porphyry and massive rhyolite.

7 Green, fine-grained, bedded sandstone, tuffaceous sandstone, graywacke and arkose.

6 Mafic pillow lava, agglomerate and tuff; minor interbedded red and green chert and sandstone; 6a, massive basalt, tuff and minor felsic rocks.

5 Gray-green graywacke and conglomerate, minor sandstone, siltstone, slate and argillite; 5a, conglomerate.

MIDDLE ORDOVICIAN (Caradocian)

4 Black slate, shale and argillite; interbedded chert and graywacke, minor pyrite beds.

MIDDLE ORDOVICIAN AND OLDER (May include younger rocks in places)

VICTORIA LAKE GROUP (Units 2-3)

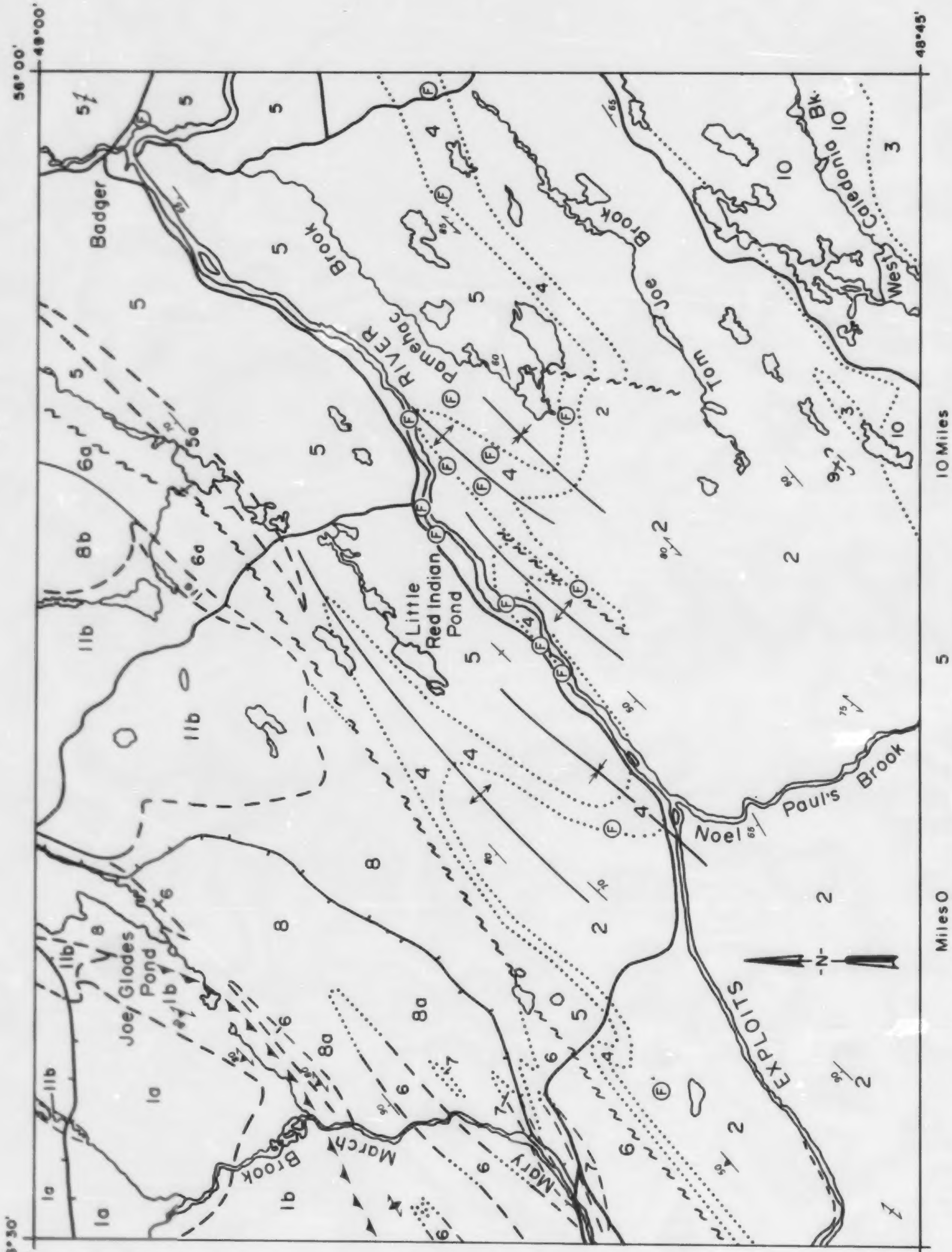
3 Tally Pond volcanic rocks; unseparated acidic and mafic tuff, flows and mafic pillow lava.

2 Gray and green sandstone, siltstone, chert, argillite, shale and graywacke.

HUNGRY MOUNTAIN COMPLEX

1 1a, gabbro and diorite; 1 b, granodiorite and minor granite.

Schistosity: related to thrusting. . . . .


56°00'
49°00'
48°45'
56°30'
49°00'
48°45'
Badger
RIVER
EXPLOITS
Pamehac Brook
Little Red Indian Pond
Joe Glodes Pond
Tom Joe Brook
Noel Paul's Brook
March Brook
Mary
West Caledonia Bk.
N
Miles 0
5
10 Miles
Kilometres 0
5
10 Kilometres

Like the mafic phase, the ganodiorite-granite phase is predominantly undeformed. However, adjacent to the contact with the Buchans Group it shows a penetrative fabric that trends parallel to the contact.

Victoria Lake Group (Unit 2-3)

Sedimentary Rocks (Unit 2)

The southeast corner of the map area is underlain by the Victoria Lake Group (Kean, 1977a). It consists of graywacke, sandstone, siltstone, argillite, slate and chert that are interbedded with each other. Bedding in the graywacke ranges from less than 0.5 m to greater than 2 m and contains thinner (<1 cm to 0.5 m) beds of internally laminated siltstone, argillite and chert. The graywacke is characterized by rip-ups, load-casts and slumps. The siltstones and other fine grained sediments generally show flame structures and slumping; small scale cross-laminations occur at places. These rock types have sharp top and bottom contacts that commonly show scour and fill structures. The graywacke is generally more common in the lower part of the unit and contains numerous siltstone, chert, argillite and slate clasts. Locally, clasts of felsic volcanic rocks and quartz porphyry are also present.

Siltstone, sandstone, argillite and chert are best developed in the upper part of the sedimentary sequence. They also contain thin (<0.5 m) beds and lenses of graywacke. In the southwest corner of the map area black slate and shale commonly occur interbedded with these sediments and well developed Bouma sequences are preserved.

Limestone beds near the top of the sequence (south of Buchans Junction) contain conodonts of late Llanvirnian to early Llandeillo age (Stouge, 1978; unpublished report).

Tally Pond volcanic rocks (Unit 3)

A small area in the northeast corner of the map area is underlain by rocks that form a northeast extension of the Tally Pond volcanic rocks - a sequence of acidic and mafic tuffs, breccias and flows (Jayasinghe, 1979). They are poorly exposed in the map area. The only exposures are altered mafic pillow lava.

Black Shales (Unit 4)

A major formational unit of black slate and shale crosses the center of the map area. It is well delineated on airborne EM geophysical maps (McIntyre-Porcupine, 1966). Chert, argillite and in places graywacke occur interbedded with this unit; thin lenses of pyrite (<1 cm) also occur in places. It has been fossil dated in exposures along the Exploits River as Caradocian (Williams, 1970; D. Skevington, 1977, personal communication). A number of new fossil localities along the unit have been found during this year's mapping. No identification has yet been done on the newly found fossils.

Graywacke and Conglomerate (Unit 5)

An upward coarsening graywacke and conglomerate sequence stratigraphically overlies the black shale unit. The graywacke is generally coarser than those of the underlying Victoria Lake Group and it also contains more conglomerate lenses than the latter. The conglomerate lenses contain clasts of chert, shale, slate, argillite and siltstone. In places it is interbedded with a few centimetres to 1 m wide siltstone and sandstone beds. Cross-bedding, graded bedding, load casts, flame structures and scour and fill structures are common. Large scale (1m - 2m) trough crossbedding has developed in places towards the upper part of the sequence. Conglomerates are common in the upper part of the sequence where a number of prominent conglomerate lenses (unit 5a) occur as mappable units interbedded with graywacke. These are characterized by the presence of well-rounded granite and granodiorite pebbles and cobbles. The other clasts are angular to subrounded and are composed mostly of chert, siltstone, argillite and slate. Also present are minor, white and black quartz rhyolite porphyry and limestone clasts.

Buchans Group (Units 6, 7 and 8)

Units 6-8 are assigned to the Buchans Group and are considered to be part of the Lower Buchans Subgroup (Kean, 1979).

Unit 6 consists of mafic pillow lava, agglomerate and mafic tuff with minor interbedded red chert, chert breccia and green sandstone. They are equivalent in part to the Basal Basalt or Footwall Basalt of the Lower Buchans Subgroup (Kean, 1979).

Green quartzose sandstone and tuffaceous sandstone and graywacke containing quartz, feldspar and pink rhyolite clasts comprise unit 7. This unit is lithologically similar to and occupies the same stratigraphic position as the Footwall Arkose and Prominent Quartz Sequence of the Lower Buchans Subgroup.

Silicic volcanic rocks (unit 8) consisting of dacitic and rhyolitic breccias and tuff, massive flows and quartz-feldspar porphyry and crystal tuff are all tentatively assigned to the Lower Buchans Subgroup on the basis of their stratigraphic position. But, many of the breccias and quartz-feldspar porphyries lithologically resemble rocks of the Upper Buchans Subgroup.

Intrusive Rocks

Gabbro (Unit 9)

Small bodies and sills (4 m wide) of gabbro occur intruding Units 2 and 5, most of these are too small to be shown in the accompanying map. They are fine to medium grained and do not generally contain a fabric.

Cripple Back Lake quartz monzonite* (Unit 10)

The Cripple Back Lake quartz monzonite has been emplaced into units 2 and 3. However, the actual contact is not exposed. The pluton is medium grained and locally porphyritic with small (<1 cm) whitish to pink, lath-shaped feldspar phenocrysts in a groundmass consisting of quartz, feldspar, biotite and hornblende. No penetrative fabric is seen in the intrusion. In places it is cut by fractures that are commonly filled with pyrite and chalcopyrite.

Skull Hill granite* (Unit 11)

The Skull Hill granite occurs in the northeastern corner of the map area and has been interpreted as a part of the biotite granite phase of the Topsails Granite (Kean, 1979; Taylor, *et al.* in preparation).

Diabase and fine to medium grained diorite and gabbro (unit 11a) forms an earlier phase of this unit. In places diabase and gabbro with an alkaline affinity appear to be with the granitic (*s.l.*) phase (unit 11b). Unit 11b consists of fine to medium grained, red, equigranular syenite, quartz-syenite, and granite; alkasitic varieties and feldspar porphyritic phases are developed in places. Hornblende is the most common mafic mineral, in places as acicular needles.

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*These names are used informally throughout this report. They will be formally proposed in later publications.

METAMORPHISM AND STRUCTURE

The sedimentary and volcanic rocks of the map area are in the sub-greenschist to greenschist facies. No contact metamorphic aureoles were noted adjacent to the intrusions, but, this may be due to the poor exposure in the area.

The rock units in the area are folded into a series of major anticlines and synclines that plunge at moderate angles in a northeasterly direction. In places (*e.g.* along Exploits River), parasitic minor folds occur on the limbs of the major folds. A widespread northeast trending, moderate to steeply dipping cleavage occurs axial planar to the folds.

There are two major faults in the area. One separates the Hungry Mountain Complex from the Buchans Group and the other separates the Buchans Group from unit 5. The former trends in a northeast to north-south direction and has steep dips. Farther to the southwest, it has been interpreted as a thrust fault along which the Hungry Mountain Complex has been thrust over the Buchans Group prior to the major folding in the area (Kean, 1979). The fabric in the Buchans Group becomes progressively more intense towards the contact with the Hungry Mountain Complex. The second major fault trends in a northeast direction more or less parallel to the strike of the rocks. In addition, a number of north-northeast trending minor faults occur in the southern part of the area displacing the limbs of the major folds.

MINERALIZATION

No significant mineral showings have been discovered in the area. Sulphide boulders containing pyrite, chalcopyrite and galena occur southeast of Leonards Lake. Disseminated pyrite occurs throughout subunit 8a.

ACKNOWLEDGEMENTS

The authors thank Ralph Skinner and Dennis Rowsell for able assistance in the field. W.R. Smyth, D. Bailey and T. Rivers reviewed the manuscript.

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GEOLOGY OF PARTS OF THE BURNT HILL MAP AREA (2D/5), NEWFOUNDLAND

by

S.P. Colman-Sadd

INTRODUCTION

Mapping of the Burnt Hill area was started in 1978 (Colman-Sadd, 1979) and continued in 1979. Access to most of the area is by aircraft; much of the Northwest Gander River is navigable by canoe, even in dry weather, and is a great aid to mobility. Peripheral parts of the area can be reached from the Bay d'Espoir Highway (eastern edge, and northern edge via the Great Rattling Brook road), Round Pond and the Long Pond reservoir (southwest corner), and the Grand Falls transmission line (southern edge).

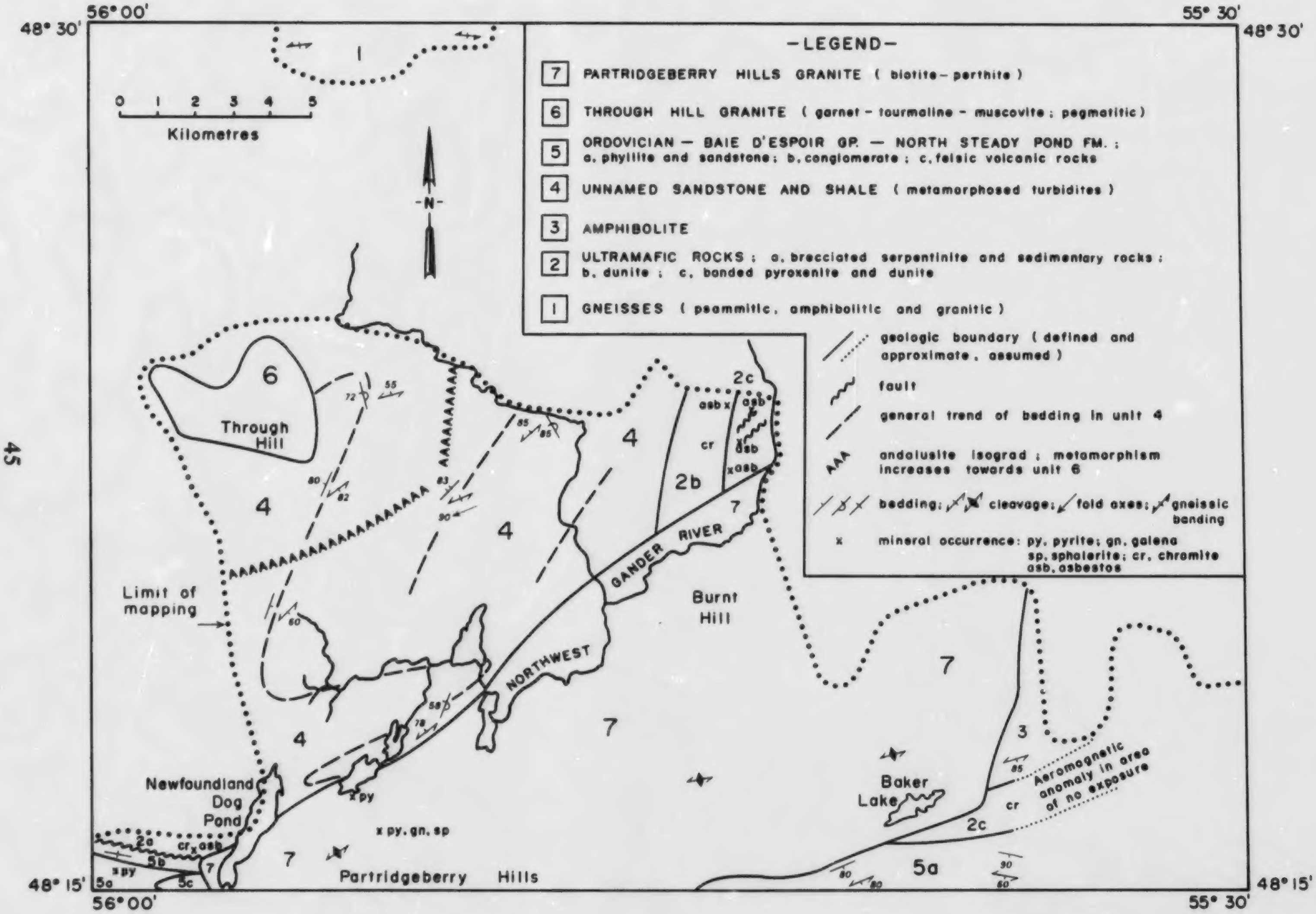
The area was mapped previously by Anderson and Williams (1970) at a 1:250,000 scale. Grady (1953) mapped the ultramafic rocks north of Burnt Hill for the Newfoundland Government, and these were further investigated by NALCO geologists (Harrison, 1953; Gates, 1954; Potter, 1955) and Bell Asbestos Mines Ltd. (1963). McCabe (1955) mapped the Baker Lake ultramafic body for NALCO. Butler and Davenport (1978) did a lake sediment geochemistry study through the whole area.

Rocks of the Burnt Hill area are divided into four main groups: gneisses (Unit 1), ultramafic rocks (Unit 2), sedimentary and volcanic rocks (Units 3, 4, 5) and granitic intrusions (Units 6 and 7). The gneisses have been examined in one isolated locality and their relationship to the other rocks is unknown. They are much more deformed and metamorphosed and appear to have different original compositions from any of the other units. The ultramafic rocks are known to be in fault contact with the Baie d'Espoir Group (Unit 5) near Newfoundland Dog Pond, and it is thought that their other contacts with the group and Unit 4 are faulted. It is possible that they are related to the amphibolites (Unit 3), if the latter originated as part of an ophiolite suite. The Baie d'Espoir Group has not been seen in contact with Unit 4 and may be separated from it everywhere by faults and ultramafic rocks. The rock types and structural attitudes of the two units are distinct. The Through Hill granite intruded Unit 4 after the main period of folding. The Partridgeberry Hills Granite intruded Unit 4, the Baie d'Espoir Group and the ultramafic rocks after the main deformation in each; there are parts of the granite, however, which have been deformed and a late deformation in the Baie d'Espoir Group appears to have occurred during or after intrusion. The name, Through Hill granite, is used informally throughout this report. It will formally proposed in a later publication.

GNEISSES (Unit 1)

Three varieties of gneiss have been recognized, although it is not practical to separate them on the map. The first is a medium to coarse grained rock of granitoid composition, in which biotite-rich foliae and quartz-feldspar domains define a very strong, segregated foliation. The spacing of the foliae is in the order of 1 to 2 cm and intrafolial folds are common. The gross homogeneity and composition of the gneiss sugggest derivation from a plutonic intrusion. It contains inclusions of banded psammitic and amphibolitic gneiss, which originally may have been xenoliths.

The second group of gneisses are well banded. They consist mainly of


48° 30'
56°00'
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48° 15'
56°00'
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0 1 2 3 4 5
Kilometres
-N-
-LEGEND-
7 PARTRIDGEBERRY HILLS GRANITE (biotite-perthite)
6 THROUGH HILL GRANITE (garnet - tourmaline - muscovite ; pegmatitic)
5 ORDOVICIAN — BAIE D'ESPOIR GP. — NORTH STEADY POND FM. : a. phyllite and sandstone; b. conglomerate ; c. felsic volcanic rocks
4 UNNAMED SANDSTONE AND SHALE (metamorphosed turbidites)
3 AMPHIBOLITE
2 ULTRAMAFIC ROCKS : a. brecciated serpentinite and sedimentary rocks ; b. dunite ; c. banded pyroxenite and dunite
1 GNEISSES (psammitic, amphibolitic and granitic)
geologic boundary (defined and approximate, assumed)
fault
general trend of bedding in unit 4
andalusite isograd ; metamorphism increases towards unit 6
bedding; cleavage; fold axes; gneissic banding
x mineral occurrence: py, pyrite; gn, galena sp, sphalerite; cr, chromite asb, asbestos
Through Hill
Limit of mapping
Newfoundland Dog Pond
Partridgeberry Hills
NORTHWEST
GANDER RIVER
Burnt Hill
Baker Lake
Aeromagnetic anomaly in area of no exposure
x py. gn. sp
x py
cr x asb
asb x
asb
x asb
cr
2a
2b
2c
5a
5b
5c
7
6
4
3
1

coarse grained, biotite-rich psammite and foliated amphibolite; the bands are 10 cm to 1 m wide. Although these gneisses may have had a sedimentary protolith, they have no vestige of sedimentary structure and the banding is not considered to be related to bedding.

The third group of gneisses consists of regular bands of fine grained psammite and coarse grained,biotite-rich pelite. The bands are 2 to 5 cm thick and could well represent bedding in an originally rhythmically bedded sandstone and shale sequence. The origin of these rocks may be more obvious when their relationship to the sedimentary rocks farther south has been determined.

The gneissic rocks contain and are cut by pods, lenses and small veins of undeformed, medium grained, biotite granite.

ULTRAMAFIC ROCKS (Unit 2)

Ultramafic rocks occur at three locations. At the first of these, near Newfoundland Dog Pond, they form part of a breccia that includes volcanic and sedimentary rocks of the Baie d'Espoir Group. This locality was described by Colman-Sadd (1979).

The Baker Lake ultramafic body, at the southeast corner of the Partridgeberry Hills Granite, is on trend with that at Newfoundland Dog Pond, and the two may have been continuous before the intrusion of the granite. The eastward extension of the Baker Lake body is uncertain because of lack of exposure, but aeromagnetic evidence (Geological Survey of Canada, 1968) suggests that it may continue in a northeasterly direction to the edge of the map area. It consists of massive pyroxenite, massive dunite and irregularly banded pyroxenite and dunite; all the rock types are more or less serpentinized. Dunite occurs as blocks in the pyroxenite, but also forms veins that cut across it. Disseminated chromite and minor asbestos veins occur in the dunite, and veins of magnesite have been found cutting both the dunite and pyroxenite. A few exposures of very sheared pyroxenite are thought to indicate faulting; one of these, at the south edge of the body, suggests an overthrust relationship with the Baie d'Espoir Group.

Only a part of the ultramafic body north of Burnt Hill has been mapped. Although its structural trends are discordant to the other bodies, its rock types are similar to those of the Baker Lake body, and it is considered to be related. Dunite, with disseminated chromite and small asbestos veins, forms a mappable entity in the west. This is bounded to the east by banded pyroxenite and dunite, massive pyroxenite, and sheared serpentinite. Dunite occurs both as irregular blocks in the pyroxenite and as veins cutting across dunite and pyroxenite. Asbestos veins, up to 1 cm wide, seem to occur preferentially near the contact of the massive dunite with the pyroxenite, but more mapping will be required to determine whether this is a consistent relationship.

SEDIMENTARY AND VOLCANIC ROCKS (Units 3-5)

Amphibolite (Unit 3)

Amphibolite is exposed at two localities along the eastern edge of the Partridgeberry Hills Granite. It is the only rock type, other than granite, that has been found in the area mapped so far between the ultramafic bodies at Baker Lake and north of Burnt Hill. The amphibolite is fine grained. At the southern exposure it has a moderate planar cleavage, but at the northern one, poorly defined massive blocks lie in a slightly coarser matrix with an undulating foliation. The original nature of the amphibolite at both localities is obscure, although the massive blocks at the northern exposure may possibly be pillows.

Unnamed Sandstone and Shale (Unit 4)

The rocks of Unit 4 occur in the central part of the map area, and at present their age and relationship to other sedimentary rocks in Newfoundland is unknown.

They consist of turbidites with sandstone beds typically 10 cm or more thick and shale beds varying from 1 cm to 1 m. The sandstones are much more mature and quartz-rich than those of the North Steady Pond Formation (Unit 5) farther south. They are medium to fine grained and commonly show graded bedding, load structures and ripple drift lamination.

The rocks of Unit 4 are tightly folded around axes that plunge vertically or steeply to the southwest. A well developed axial planar cleavage strikes southwest and, in general, is nearly vertical. Bedding cleavage intersections allow vergence determination in most exposures and the probable pattern of large-scale folding is shown on the map. The folding appears, in the field, to be the first deformation. However there is some conflict in the facing directions of bedding on the cleavage, which may indicate an earlier disturbance.

Most of Unit 4 has been metamorphosed in the greenschist facies. A very narrow zone of hornfels is developed adjacent to the Partridgeberry Hills Granite where the shales have a metamorphically induced spottiness. A much broader zone of amphibolite facies metamorphism surrounds the Through Hill granite; andalusite porphyroblasts have overgrown the cleavage in the shale beds and the andalusite isograd has been superimposed on the earlier folds (see map). At the edge of the Through Hill granite the sedimentary rocks are crosscut by granite dikes, and partially assimilated blocks of sandstone and shale are found in the granite. Bedding and other sedimentary structures are preserved even at the highest grades of metamorphism, and there is no doubt that all these rocks belong to the same unit.

North Steady Pond Formation (Unit 5)

The rocks of this formation occur along the southern edge of the map area and form the northern continuation of the Baie d'Espoir Group. They are, therefore, probably of Middle Ordovician age, on the basis of fossil localities in the Great Gull Lake (Anderson and Williams, 1970) and St. Alban's (Colman-Sadd, 1976) areas.

The formation consists mainly of immature turbidites containing clasts of fresh feldspar and volcanic rock fragments. It includes minor resedimented conglomerate, and felsic and intermediate lavas and pyroclastic rocks. The descriptions of the formation by Colman-Sadd (1979, in press) apply to its continuation in the Burnt Hill area and are not repeated here.

GRANITIC INTRUSIONS (Units 6 and 7)

Through Hill Granite (Unit 6)

The Through Hill granite is a pegmatitic leucogranite. Almost all exposures contain abundant garnet, and tourmaline is also common. Muscovite is the principal mica, but biotite is also present in most places particularly where there has been assimilation of the surrounding metasedimentary rocks.

The granite is undeformed and postdates the structures in the country rocks.

Partridgeberry Hills Granite (Unit 7)

The granite forms a large intrusion, elongated in a west-southwest direction parallel to the regional structural trend. It varies from predominantly granite in the west to predominantly granodiorite in the east (P. Elias, personal communication). It is medium to coarse grained, gray or pink, locally vuggy and pervasively altered. The alkali feldspar is perthite, indicating a high level of intrusion; it forms subhedral phenocrysts in the northern half of the intrusion and these have a slight southwesterly alignment. The principle mica is biotite, but in most places this has been altered to chlorite; primary muscovite is rare. The granite is cut by numerous quartz veins, but aplites and pegmatites are very scarce.

The southeastern half of the intrusion has a moderate foliation. In most places the foliation is not attributed to deformation of the granite, but rather to the partial assimilation of foliated country rocks (Colman-Sadd, in press). There are parts of the granite, however, that have been deformed and have a cataclastic fabric.

OTHER INTRUSIONS

The following minor intrusions are not separated on the map:

a single undeformed diabase dike, intruded into the Through Hill granite (P. Elias, personal communication), 10 m wide felsite dike with pyrite, galena and sphalerite mineralization, cutting the southwestern part of the Partridgeberry Hills Granite, and a large dike of vuggy quartz, also cutting the Partridgeberry Hills Granite.

MINERALIZATION AND ECONOMIC POTENTIAL

Disseminated chromite occurs throughout the ultramafic rocks, but nowhere are there any significant concentrations. Asbestos occurs in the serpentine breccia near Newfoundland Dog Pond; however the best fibre and the most widespread occurrences are in the ultramafic body north of Burnt Hill, where they have been mapped by NALCO geologists (Harrison, 1953; Gates, 1954; Potter, 1955) and drilled by Bell Asbestos Mines Ltd. (1963). No economic concentrations have yet been discovered.

Potential in the volcanic and sedimentary rocks lies in the amphibolite (Unit 3) and the North Steady Pond Formation (Unit 5); Unit 4 appears to consist entirely of barren turbidites. A tentative interpretation of the amphibolite as forming the upper part of an ophiolite suite (based at present on only two exposures), would suggest the possibility of Cyprus-type massive sulphide deposits. The North Steady Pond Formation is on strike with and probably laterally equivalent to the mineralized Great Burnt Lake volcanic belt. It is considered to have been deposited on the eastern flank of the pre-Caradocian island arc of Dean (1977). As such it holds potential for Kuroko-type massive sulphide deposits associated with its included felsic volcanic rocks. A grab sample from a pyritiferous felsic crystal tuff at Newfoundland Dog Pond brook (Colman-Sadd, 1979) assayed 60 ppm Pb, 67 ppm Zn, 17 ppm Cu, 10 ppm Ag.

The Through Hill granite is an excellent example of a two-mica granite. It may therefore have potential for uranium mineralization, although no anomalous radioactivity was discovered during mapping. The two mineral occurrences in the Partridgeberry Hills Granite are associated with the quartz and felsite dikes that have intruded it. A pyritiferous sample of granite adjacent to the quartz vein assayed 393 ppm Pb, 22 ppm Zn, 105 ppm Cu, 1 ppm Ag. A grab sample from the felsite dike assayed 2170 ppm Pb, 233 ppm Zn, <10 ppm Cu, <1 ppm Ag, 0.4 ppm Au. No anomalous radioactivity has been recorded from this granite.

ACKNOWLEDGEMENTS

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GRANITE GEOCHEMISTRY PROJECT-BAY D'ESPOIR AREA

by P. Elias

INTRODUCTION

The Bay d'Espoir Granite Geochemistry Project was started in 1978 (Elias, 1979). Twelve intrusions, mostly granitoid, were sampled and analyzed. During the 1979 season, the field aspect of the project was completed with the mapping and sampling of two additional plutons in the Twillick Brook (2D/4) and Burnt Hill (2D/5) map areas. Plutons sampled so far are shown in figure 1. The project continues to be a joint undertaking between the Mineral Development Division and the Geology Department, Memorial University of Newfoundland.

MAPPING AND SAMPLING

Mapping of the Partridgeberry Hills and Through Hill plutons on a 1:50,000 scale was completed during the 1979 field season by Colman-Sadd (this volume). Sample locations were obtained by means of a slightly modified version of an inverted nested grid sampling method (Garrett and Goss, manuscript). Sample locations within 4 km^2 grids were selected on an opportunity basis where outcrop distribution warranted. 71 samples were taken from the Partridgeberry Hills Granite and 19 from the Through Hill granite.

ANALYTICAL AND OTHER WORK

The granite samples collected will be examined petrographically and analysed for all major elements in addition to the following trace elements:

Ba Be Ce Cr Cu F Ga La Li Mo
Nb Ni Pb Rb S Sr Th U V Y Zn
Zr.

The following preliminary results are reported on the basis of follow-up work on plutons sampled in 1978.

1. Provisional calculations on an eleven-point Rb-Sr whole rock isochron yield an age of 344 ± 52 Ma for the Gaultois Granite. Refinement of the calculations, currently underway, should considerably reduce the uncertainty factor (52 Ma) associated with the age. The initial ratio of $Sr^{87}:Sr^{86}$ was 0.7105.

2. Attempts to erect an eleven point isochron for the North Bay Granite and associated intrusions have been less successful. Data points define three separate subparallel isochrons yielding a provisional age of *ca.* 420 Ma and initial ratio of 0.7065. Further processing of the data is in progress.

3. Samples from the Long Pond diorite, Missing Island Granodiorite and the North Bay Granite (all in the Twillick Brook map area) plot on a six point Rb-Sr whole rock isochron, indicating the same age for them (420 Ma), and a probable genetic relationship.

4. It is proposed to establish a ten point Rb-Sr whole rock isochron for the Partridgeberry Hills Granite. Samples for this project have already been collected.

5. The southeast equigranular and Northwest Cove Granites are virtually identical in chemistry, mineralogy and texture. They probably have a close genetic relationship, and may even belong to the same pluton.

LEGEND

1 Piccaire Granite: Massive equigranular biotite granite.

2 Gaultois Granite: Foliated megacrystic biotite granite.

3 Northwest Cove Granite: Foliated muscovite-biotite granite.

4 Straddling Granite: Foliated muscovite-biotite granite.

5 Southeast equigranular granite: Foliated muscovite-biotite granite.

6 Dolland Bight Granite: Foliated muscovite-garnet granite.

7 North Bay Granite: Mildly foliated biotite-muscovite granite and granodiorite.

8 Missing Island Granodiorite: Massive biotite granodiorite.

9 Long Pond diorite: Massive hornblende diorite.

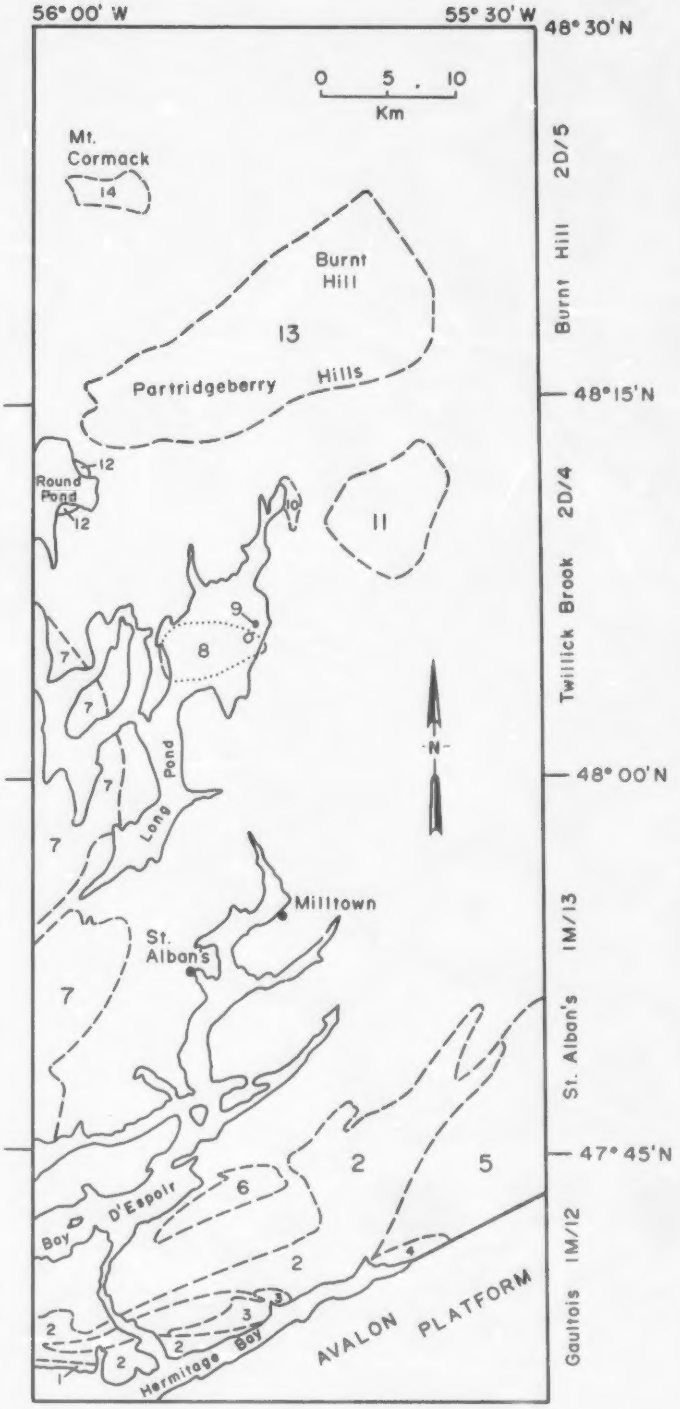
10 Rocky Bottom Tonalite: Massive biotite tonalite.

11 Matthews Pond Granodiorite: Massive biotite granodiorite.

12 Round Pond Gabbronorite: Mildly foliated gabbro and granodiorite.

13 Partridgeberry Hills Granite: Mildly foliated biotite granite and granodiorite.

14 Through Hill granite: Massive muscovite - garnet granite.


56° 00' W
55° 30' W
48° 30' N
48° 15' N
48° 00' N
47° 45' N
0 5 10
Km
Mt. Cormack
14
Burnt Hill
13
Partridgeberry Hills
Round Pond
12
10
11
9
8
7
Long Pond
N
Milltown
St. Alban's
6
2
5
Bay D'Espoir
3
4
1
Hermitage Bay
AVALON PLATFORM
2D/5 Burnt Hill
2D/4 Twillick Brook
IM/13 St. Alban's
IM/12 Gaultois

6. Except for small showings of molybdenite in pegmatites associated with the North Bay Granite, and a small fluorite occurrence in the southeast equigranular granite, the granites are devoid of economic mineralization. Radioactivity counts are about 100-200 cps. Beryl and apatite occur only rarely in pegmatites most of which are otherwise barren, despite their abundance.

ACKNOWLEDGEMENTS

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GEOLOGY OF THE GANDER (WEST) AREA (2D/15), NEWFOUNDLAND

by

R.F. Blackwood

INTRODUCTION

The west half, and the northwest corner of the east half, of the Gander (2D/15) area was mapped on a 1:50,000 scale during the 1979 field season. Mapping also included the southeast corner of the Mount Peyton (2D/14) area, which is adjacent to and west of the Gander area. This work forms part of the larger Gander Rivers Project that was initiated in 1978 (Blackwood, 1979a).

Access to the area west of The Outflow and Southwest Gander River was provided by wood roads; to the east traversing was done from the Trans Canada Highway and Gander Lake. The Hunts Pond and south area was completed by flycamp (fixed wing) and helicopter.

Bedrock exposure along Gander Lake and in some brook sections is nearly continuous; elsewhere it is dismal.

Alexander Murray in 1874 and J.P. Howley in 1875 (Murray and Howley, 1881) worked along Gander Lake and separated metamorphic rocks in the east from sedimentary rocks in the west and noted intervening ultramafic rocks.

MacClintock and Twenhofel (1940) included the area in a account of surface features and Wisconsin glaciation of Newfoundland.

Phyllites, slates and quartzites along Gander Lake were named the "Gander Lake series" by Twenhofel (1947). He interpreted these rocks to be of Silurian age.

Jenness (1958) mapped and defined the Gander River Ultrabasic Belt, east of Gander River. He interpreted mafic to ultramafic rocks in the belt to be intrusive into Twenhofel's "Gander Lake Series" which he renamed the Gander Lake Group; brachiopods indicated a Middle Ordovician age for the group.

The Gander Lake Group was subdivided into Lower, Middle, and Upper Units by Jenness (1963) and interpreted as a conformable sequence. Ordovician fossils were found only in the Middle and Upper Units. Anderson and Williams (1964) showed the Upper Unit of the Gander Lake Group to be overlain in the west by Silurian sedimentary rocks of the Botwood Group (Williams, 1962).

The fossiliferous Middle and Upper Units of Jenness' Gander Lake Group were redefined as the Middle Ordovician Davidsville Group by Kennedy and McGonigal (1972); it was described as overlying the pre-Middle Ordovician Gander Lake Group (mostly the Lower Unit of Jenness) by an inferred major angular unconformity. The name "Gander Lake Group" was shortened to Gander Group by McGonigal (1973).

Kennedy (1975) described an unconformity between basal conglomerates of the Davidsville Group and altered ultramafic rocks of the Gander River Ultrabasic Belt, on the north shore of Gander Lake.

Currie *et al.* (1979) working northeast of the present area, described rocks previously designated as the Gander Group as conformable with rocks of the Davidsville Group. Blackwood (1978, 1979b) defined the nonconformable nature of the Davidsville Group/Gander River Ultrabasic Belt (GRUB line) contact, northeast of Gander Lake.

LEGEND

DEVONIAN (?)

13 Fine to medium grained, pink granite

12 Fine grained gabbro

11 Medium grained, two-mica, garnetiferous, leucogranite.

SILURIAN

BOTWOOD GROUP

10 Red and gray sandstone and shale, locally micaceous; minor fossiliferous calcareous beds.

MIDDLE ORDOVICIAN AND LATER

DAVIDSVILLE GROUP

9 Fine to coarse grained graywacke, locally with shale intraclasts, interbedded with gray to black siltstone and shale.

8 Gray to black shale and siltstone; minor red slate and minor graywacke.

7 Medium to coarse grained gray sandstone with pebble lenses, minor red sandstone, conglomerate, limestone (marble), and calcareous siltstone

MIDDLE ORDOVICIAN OR EARLIER

GANDER RIVER ULTRABASIC BELT (GRUB)

6 Brecciated quartz porphyry

5 Fine grained volcaniclastic rocks; minor porphyritic mafic flows

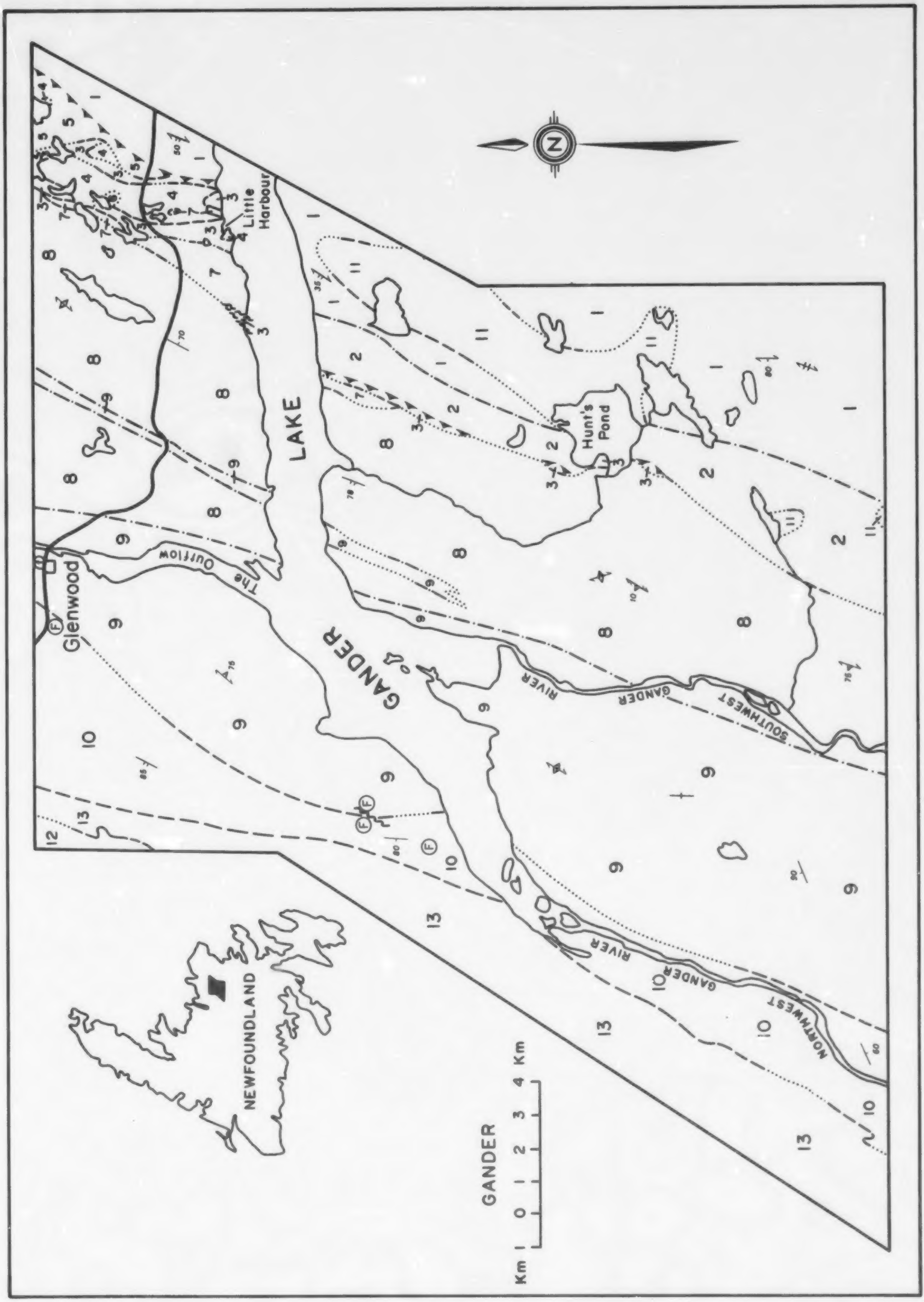
4 Fine to coarse grained gabbro

3 Pyroxenite, minor dunite and periodite, serpentinite, magnesite, and talc-actinolite schist.

GANDER GROUP

2 Semipelite, pelite, minor psammite, and concordant amphibolite bands.

1 Psammite and semipelite; minor mafic tuffs.


Glenwood
The Outflow
GANDER LAKE
Hunt's Pond
Little Harbour
SOUTHWEST GANDER RIVER
NORTHWEST GANDER RIVER
NEWFOUNDLAND
GANDER
Km 1 0 1 2 3 4 Km
N

Several exploration companies have mapped in the area, concentrating on the GRUB line.

GENERAL GEOLOGY

The area comprises four tectonostratigraphic subdivisions: the Gander Group (1-2), the Gander River Ultrabasic Belt (3-6), the Davidsville Group (7-9), and the Botwood Group (10). The Gander Group is intruded by leucogranite (11). Gabbro (12) is intruded by pink granite (13) which also intrudes the Botwood Group.

The Gander Group is interpreted to be in fault contact with the GRUB line which is nonconformably overlain by the Davidsville Group. The exact relationship between the Davidsville and Gander Groups is not known; they may be conformable in areas where the GRUB line is missing. The Botwood and Davidsville Groups are apparently conformable, however the close proximity of Middle Ordovician and Silurian fossil localities may suggest a disconformity between the two groups.

Gander Group (Units 1-2)

The Gander Group underlies the eastern margin of the area and forms two mappable units south of Gander Lake. Psammites, semipelites and pelites with interbedded feldspathic quartzites comprise Unit 1, north of the lake. The light gray feldspathic quartzite beds range in thickness from 15 cm to 1.5 m and commonly form sharp boundaries with light to greenish gray, laminated psammite. Pelitic material occurs as 5-10 cm intercalations but locally predominates in areas underlain by light to dark gray pelite and semipelite. Close to the contact with the GRUB line, minor mafic volcaniclastics containing epidote knots and stringers are conformable with the pelites.

Unit 1 is of low greenschist metamorphic grade north of Gander Lake and middle amphibolite facies grade south of the lake. Coarse cordierite or andalusite porphyroblasts range in length from 2-8 cm. Biotite and garnet are common; hornblende and staurolite also occur. Narrow pelitic laminations in psammite are accentuated by a concentration of biotite porphyroblasts. The phyllitic fabric north of the lake is replaced by a fine to coarse grained schistosity south of the lake. Porphyroblasts are mostly posttectonic but may form weak augen structures; the muscovite-biotite schistosity is a preferred orientation caused by mimitic crystalization. The higher metamorphic grade is related to the emplacement of late synkinematic to posttectonic leucogranite (11).

The structural top of the Gander Group, south of Gander Lake, is marked by pelitic to semipelitic schists containing concordant amphibolite bands (Unit 2). These bands are common and vary from 20 cm to 4 m in width. The amphibolites are interpreted to be the higher metamorphic equivalent of mafic tuffaceous bands that occur north of the lake; however, some bands are discordant in detail suggesting that they were originally mafic dikes. Units 1 and 2 are gradational and are overprinted by the same metamorphic event.

The Gander Group is polydeformed. A fine, first fabric (S_1) is best developed in pelitic zones and is generally parallel to bedding. It is axial planar to rarely seen, small scale, isoclinal F_1 folds. A composite fabric (S_2) is pervasive and clearly transposes S_1 in pelitic zones. This second foliation is axial planar to recumbent, tight to isoclinal, small and large scale F_2 folds. Axial planes generally dip gently to moderately to the west-northwest; *i.e.*, folds are overturned to the southeast. Where small scale F_2 folds overprint F_1 folds, type 3 interference patterns are produced. Locally, upright, open to tight, F_3 structures are developed. A crenulation cleavage is axial planar to these latest folds.

Gander River Ultrabasic Belt or GRUB line (Units 3-6)

The GRUB line forms a linear, northeast trending, 2-3 km wide zone north of Gander Lake. It largely comprises mafic to ultramafic plutonic and volcanic rocks that are continuous with identical rock types in the Gander River map area (Blackwood, 1979b). The contact between these rocks and the Gander Group is not exposed in the Gander map area but elsewhere it is a fault (Blackwood, 1979a, 1979b).

Ultramafic rocks and their altered equivalents (unit 3) are the oldest rocks in the GRUB line. Medium to coarse grained pyroxenite predominates but minor dunite and peridotite also occur. Serpentinization is widespread and produces massive serpentinite zones as well as a patchy alteration pattern where pods of unaltered ultramafic rock "float" in a serpentinite matrix. Similarly, fragments of large pyroxene crystals are isolated and surrounded by antigorite. Magnesite is also a common alteration product but is less extensive in the Gander map area than to the northeast. Both altered and unaltered ultramafic rocks locally have a crude banding, best seen on weathered surfaces.

Fine to coarse grained gabbro (Unit 4) is intrusive into the ultramafic rocks and forms a central core to the GRUB line in this area; for the most part the ultramafic rocks are disposed around it. Pods and rafts of pyroxenite locally occur as xenoliths within the gabbro but generally contacts are poorly defined. A peculiar, fragmental texture is developed in the gabbro body west of Little Harbour on the north shore of Gander Lake. It produces oligomictic zones of angular to well-rounded gabbro clasts that are gradational into massive gabbro protolith. The same pattern is developed in trondhjemite dikes which cut the gabbro; massive dike centers grade into "clastic-like" margins which form sharp boundaries with fragmental gabbro. Unseparated, minor, mafic volcaniclastic pods are associated with the gabbro and included in Unit 3.

Fine to medium grained volcaniclastic rocks (Unit 5) form part of the GRUB line north of Gander Lake. Greenish-gray tuffaceous bands contain epidote blebs and calcite stringers; rare porphyritic mafic flows are interlayered with the laminated, reworked tuff.

A small body of quartz porphyry (Unit 6) intrudes gabbro north of the Trans Canada Highway. Small quartz phenocrysts are conspicuous in a fine grained, gray, siliceous matrix. The porphyry is pervaded by anastomosing breccia zones several metres wide; on white weathered surfaces the rock resembles an acid pyroclastic. Similar autobrecciated porphyry and trondhjemite bodies occur in the GRUB line to the northeast and are interpreted to be related. In the Gander map area no trondhjemite plutons occur but trondhjemite dikes are common.

The GRUB line varies abruptly between the north and south sides of Gander Lake. A 20-30 m talc schist zone with minor actinolite, serpentinite, and pyroxenite (Unit 3) defines the line south of the lake. More massive pyroxenite, amphibolite and minor gabbro occur at Hunts Pond. The GRUB line is not exposed southwest of Hunts Pond in the Gander map area.

A well developed, low greenschist tectonic fabric overprints most of the GRUB line. It is most intense in fine grained gabbro, volcaniclastic rocks and altered ultramafics. Locally, narrow mylonite zones are developed in the gabbro. Posttectonic talc and amphibole rosettes are developed in the narrow schist zone south of the lake; the GRUB line is affected by the same higher grade metamorphism as the Gander Group in that region.

Davidsville Group (Units 7-9)

The Davidsville Group underlies the central part of the map area and is subdivided into three lithologic units. It sits nonconformably upon the GRUB line but may be conformable with the Gander Group where the GRUB line is not developed.

The base of the Davidsville Group (Unit 7) is marked by minor, polymictic conglomerate, an outlier of which produces the classic nonconformity between the Davidsville Group and serpentinite of the GRUB line just east of Little Harbour. The conglomerate sits directly upon the altered ultramafic rock and contains clasts of all the GRUB line rock types. Medium to coarse grained, gray and minor red sandstones also occur in outliers on the GRUB line as well as adjacent to it in the west. The sandstone is rich in quartz and feldspar; in some areas quartz-porphyry pebbles form conglomeratic beds and isolated clasts, surrounded by a sandy matrix. Conspicuous bright green serpentinite, trondhjemite, and garnet detritus also occur. Interbedded with the sandstone are 4-6 cm thick, calcareous siltstone beds on the north side of the lake. Limestone (marble) beds 3-25 cm thick are interbedded with quartzites on the south shore of Gander Lake.

Rocks of Unit 7 grade abruptly westward into gray and minor red shales and siltstones (Unit 8). The shales are locally laminated; interbedded siltstone beds are 2-12 cm thick and have sharp boundaries. Coarser, minor graywacke beds occur at some localities. Unit 8 appears gradational with Unit 2 of the Gander Group, southwest of Hunts Pond.

Well bedded, fine to coarse grained graywacke with interbedded siltstone and minor shale (Unit 9) constitute the westernmost part of the Davidsville Group. Graywacke beds are 5 cm to 1 m thick and have sharp coarse grained bases that grade into laminated siltstone and shale. Black and red shale intraclasts are common in the graywacke. Gray siltstone and black shale, without any graywacke beds, occur as zones within the unit. One black shale horizon near Glenwood contains Middle Ordovician graptolites (Williams, 1964). Locally, poorly sorted conglomerate lenses are developed. Coarse graywacke and interbedded siltstone also underlie a narrow, discontinuous band in Unit 8.

A pronounced slaty cleavage, axial planar to variably plunging, tight, asymmetrical folds, is developed in most of the Davidsville Group. A strain-slip cleavage/schistosity overprints the first cleavage of the Davidsville Group and is best developed south of Gander Lake. It has moderate westerly dips but is locally flat lying; recumbent folds are commonly associated. These fabrics become phyllitic to schistose in Units 7 and 8; a gradational increase in metamorphic grade continues into the Gander Group with proximity to leucogranite in the east. In the Hunts Pond and south area, phyllites and pelitic schists of the Davidsville Group are overprinted by andalusite, biotite and garnet porphyroblasts. There is apparently no structural or metamorphic break between the Davidsville and Gander Groups in the Hunts Pond area.

Botwood Group (Unit 10)

The Botwood Group underlies a narrow belt near the western margin of the map area. It is presumed to be conformable with the Davidsville Group; primary and tectonic structures are regionallly concordant between the graywackes of Unit 9 and graywackes, sandstones and shales of Unit 10. In one river section west of Gander Lake, the contact between the two groups is sheared and separates sandstone (Botwood Group) containing Silurian brachiopods from graywacke and black shale (Davidsville Group) containing *cf.Protovirgularia* sp. an Ordovician trace fossil (identified by R. Pickerill, University of New Brunswick 1979). Silurian sandstones and Middle Ordovician shales are in close proximity near Glenwood.

Red and minor gray sandstone and shale form the Botwood Group north of Gander Lake. The sandstone is fine to medium grained and commonly contains detrital muscovite. Beds range in thickness from 15 cm to 2 m and locally have erosive bases. Flame and slump structures, crossbedding, load casts, and small sandstone dikes also occur. Calcareous sandstone and shale beds are richly fossiliferous at some localities. Graywacke with shale intraclasts, gray, well bedded sandstone, and minor red sandstone and shale comprise the Botwood Group southwest of Gander Lake.

A strong slaty cleavage, axial planar to tight, variably plunging folds, overprints the Botwood Group. A strain-slip fabric is rarely developed.

Leucogranite (Unit 11)

A linear pluton of leucogranite underlies tha area between Hunts Pond, northeast to Gander Lake. Smaller bodies occur to the southwest. The granite is fine to medium grained and is characterized by a white weathering, quartz, white feldspar, muscovite assemblage. Biotite occurs locally; small, rose-colored garnets are also common. Garnetiferous aplites and pegmatites are associated with the pluton, intruding it and country rocks in the vicinity of the largest body. The main body of leucogranite is restricted to the Gander Group, however garnetiferous leucogranite veins intrude GRUB line ultramafic rocks at Hunts Pond.

The larger bodies of leucogranite are massive and unfoliated, but some of the related veins have a weak mica alignment parallel to S_2 in the Gander Group. Porphyroblasts related to the granite mostly overprint fabrics in the country rock but locally define slight augen structures.

Gabbro (Unit 12) and Pink Granite (Unit 13)

Fine grained, equigranular gabbro underlies a small area in the northwest corner of the map area. Small mafic clots, 1-3 cm across, occur locally. The gabbro is unfoliated.

Medium grained, pink, equigranular granite (Unit 13) intrudes the Botwood Group along the western margin of the map area. The actual contact is nowhere exposed but alaskitic dikes posttectonically cut red sandstone of the Botwood Group. The granite consists of pink K-feldspar and quartz; minor plagioclase and hornblende occur locally. Granodiorite and diorite phases form a small part of Unit 13. The pink granite also intrudes gabbro of Unit 12; chilled margins are not developed in the granite.

Units 12 and 13 form part of the much larger Mount Peyton batholith (Strong et al., 1974).

MINERALIZATION

Mineralization mostly occurs along the GRUB line. Picrolite (fibrous antigorite) is common in the serpentinized ultramafics. It occurs as 0.5 - 1 cm wide cross-fibre in discontinuous veins; longer slip-fibre is locally developed. Chromite occurs in altered ultramafics 1.0 km southwest of Gander Lake as disseminations, pods 1 cm to 10 cm in diameter, and lenses 2 cm wide by 1 m long.

Chalcopyrite and pyrite are disseminated throughout the quartz porphyry (Unit 6) north of the Trans Canada Highway. They also are concentrated in the comminuted matrix of breccia zones within the porphyry.

SUMMARY AND CONCLUSIONS

The Gander Group is defined as quartz-rich metasedimentary rocks, including some pelite and semipelite, that largely lie to east of, and structurally below, the Gander River Ultrabasic Belt. Sections along Gander Lake and the Trans Canada Highway in the vicinity of Gander and east are typical of the group. Mafic to ultramafic, plutonic and volcanic assemblages of the 2-4 km wide GRUB line are faulted (thrust?) against the Gander Group. The GRUB line is continuous from the Gander River map area to Gander Lake; south of the lake it thins considerably and may not have been emplaced south of Hunts Pond.

The Davidsville Group is defined as a graywacke, siltstone, shale sequence that sits nonconformably upon and largely west of the GRUB line; basal conglomerate and sandstone contain profuse GRUB line detritus. South of Gander lake, where the GRUB line is missing, the Davidsville Group is apparantly conformable with the Gander Group; a change in lithofacies, however, marks the boundary between the two groups. In the west, red and gray sandstones and shales of the Botwood Group are apparently conformable with the Davidsville Group.

The Gander Group, parts of the GRUB line, and parts of the Davidsville Group are polydeformed. The Davidsville Group has a similar deformational history to the Gander Group in their contact area south of Gander Lake. An increase in metamorphic grade is related to late, synkinematic leucogranite emplacement that also affects the Davidsville Group along its eastern margin.

The Gander Group may represent a clastic wedge that was deposited in a relatively stable area. GRUB line rocks are pre-Llanvirn (Blackwood, 1978) in age and possibly represent a dismembered ophiolite. The time of final emplacement of the GRUB line is not known, but these rocks must have been exposed as a basement to the Davidsville Group by the Middle Ordovician; conceivably the GRUB rocks could have been part of a basement to the Gander Group as well. The Davidsville Group represents a distal to proximal turbidite sequence; possibly the deeper water facies equivalent of the upper parts of of the Gander Group. These rocks pass upwards into shallower water deposits of the Botwood Group.

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PETER SNOUT, WEST HALF

by

Lesley Chorlton

INTRODUCTION

Reconnaissance 1:50,000 scale mapping of the west half of the Peter Snout area (11P/13) was completed during the summer. This area is located inland from Newfoundland's southwest coast near Burgeo, and is accessible primarily by float plane and helicopter. The nearly completed Burgeo highway passes through the east half of the Peter Snout sheet but is too far away to provide convenient, direct access to the present map area.

The map area is largely barren. The percentage of bedrock exposure is generally highest on south-facing slopes and along shallow brooks, which provide clean, illustrative outcrop surfaces. In areas covered by drift, the veneer is generally thin and composed mainly of locally derived rock fragments.

The La Poile (110/9) and La Poile River (110/16) map areas, to the west and southwest respectively, were completed during previous summers (Chorlton, 1979a, 1979b). Stratigraphic relations formulated by Cooper (1954), and modified during work on these map sheets, were used as the basis for the current mapping. Regional reconnaissance mapping by Smyth (1979), Riley (1959) and mapping on a 1:63,360 scale by Buchans Mining Co. (unpublished) afforded a geological preview.

GENERAL GEOLOGY

The map area is underlain by highly deformed and metamorphosed gabbroic, sedimentary, volcanic, and subvolcanic rock cut by granitoid rocks at several stages in their tectonic history. The sedimentary, volcanic and subvolcanic rocks belong to the probably Ordovician Bay du Nord and La Poile Groups. The gabbro bodies appear locally to be somewhat older, and may represent either remnants of oceanic crust or relatively old intrusive bodies. The early granite may be related in origin to the Rose Blanche and Port aux Basques Granites (Brown, 1976, 1977) and was intruded during the peak of metamorphism. The younger plutons were emplaced after the early, penetrative regional deformation and metamorphism. They include large bodies of porphyritic monzodiorite to granite and equigranular biotite granite north of the Bay d'Est Fault, and porphyritic, mafic-rich granite and red biotite granite south of the fault. All units were at least locally affected by late movement on the Bay d'Est Fault and contemporaneous shear zones.

Metagabbro (Unit 1)

Remnants of metagabbro bodies underlie several of the Blue Hills of Couteau. Although they generally have tectonic contacts, they have been intruded locally by the Baggs Hill Granite and very fine grained felsic stringers. Angular cobbles of quartz gabbro are included in the nearby mafic volcanic rocks.

The metagabbro forms large, black to dark green weathering outcrops, criss-crossed by numerous east trending, anastamosing shear zones. Displacement on some of these shears has probably disrupted the internal organization of the units. Many of the rocks are metamorphosed to amphibolite facies, but relict igneous textures and mineralogy (?) are found within the largest bodies. Massive medium and coarse grained pyroxene gabbro is the most widely exposed rock type; patches of layered pyroxene gabbro were observed locally. Diabase irregularly intrudes and engulfs the more coarse grained phases and is abundant in the southeastern parts of the two large pods. Stringers and fracture fillings of pearly white to cream coloured leucogranite containing large actinolite crystals cut the gabbroic rocks, but are sheared with them. Where thoroughly recrystallized, the gabbro consists of an intergrowth of hornblende and plagioclase with increased development of actinolite and talc in the late shear zones. Polycrystalline garnet clots were noted at one locality. An L-fabric, predating the late shearing and defined by the orientation of hornblende and actinolite, was observed locally.

Bay du Nord Group (Units 2-5)

The Bay du Nord Group was originally defined by Cooper (1954) as a series consisting largely of sedimentary rocks containing fossils of Devonian age. Recent work has revealed that the group contains a higher proportion of volcanic and volcaniclastic rocks than originally believed, and that most of the rocks predate the Devonian fossil-bearing strata (Chorlton, 1978; Chorlton 1979a). Field relations in the La Poile River and Peter Snout areas indicate that the Dolman formation, the newly named Piglet Brook Rhyolite (Chorlton, in preparation) and Baggs Hill Granite, all volcanic and subvolcanic units, were emplaced within the depositional cycle of the Bay du Nord volcanic and sedimentary rocks. Therefore, they are informally included in this group.

The redefined Bay du Nord Group underlies the north and central parts of the map area where it hosts several granitoid intrusions (Unit 8,9,11,13). It is in contact with lateral equivalents of the La Poile Group across the Bay d'Est Fault zone; the continuity of volcanic and sedimentary lithologies across the fault suggests that these two groups are related.

The Bay du Nord Group was deformed during at least four regional tectonic events, and metamorphosed to amphibolite grade between the first and second event. Shear zones and fabrics related to the third deformation caused variable alteration and local retrogression of metamorphic assemblages.

Bay du Nord sedimentary and volcanic rocks (Unit 2)

This unit consists of intermixed sedimentary rocks, volcanic and volcaniclastic rocks, amphibolite, migmatite, and injection gneiss. It is older than the Dolman Formation in this map area and both younger and older than the Baggs Hill Granite. Clasts from the granite and Piglet rhyolite are common in the volcanic conglomerates in the central part of the map area, but granite locally intrudes volcanic and sedimentary rocks in the La Poile River area (Chorlton, 1979a). Clasts from the Dolman formation are absent from the conglomerates in both the Peter Snout (West) and La Poile River areas. The contact with the Dolman Formation is gradational in many places, where thick deposits of intermediate crystal-lithic tuff with a graywacke-like matrix are difficult to distinguish from the more quartzofeldspathic Dolman tuff.

Non-volcanic sedimentary rocks (2a,b) occur in three areas within the map area. An east-trending belt of slate, siltstone, and graywacke (2a) extends along the north side of the Blue Hills of Couteau. To the west, where the belt is thinnest, the predominant rock type is a slaty, gray quartz-muscovite-biotite schist. Boudins of bedded siltstone and graywacke, with sandy lenses rich in quartz and feldspar detritus, display bedding which is chopped up and transposed along the dominant regional foliation. Graywacke and siltstone interbedded with laminated slate are observed to the east, where the belt is wider and deformation is less intense. On the west side of the map area, north of the Bay d'Est Fault,

LEGEND

DEVONIAN

13 Equigranular, medium grained biotite granite, locally leucocratic with minor muscovite and garnet.

12 Chetwynd Granite: 12a, medium to coarse grained pink to red biotite granite; 12b, quartz feldspar porphyry.

11 11a, porphyritic biotite granodiorite and 11b, monzodiorite (Iron-bound Hills area). Unfoliated in the north and northwest, but foliated in the south.

10 Mafic-rich, coarse grained, porphyritic granite.

PRE-DEVONIAN?

9 Foliated porphyritic granite: Otter Point Granite?; orthogneiss with alkali feldspar augen.

8 Rose Blanche Granite: 8a, foliated granodiorite, tonalite; 8b, muscovite-biotite granite, locally garnetiferous; 8c, potassic biotite granite with segregated biotite lenses (Port aux Basques Granite?); 8d, dominantly granitic blastomylonite and mylonite, including screens of injection gneiss and amphibolite, locally characterized by muscovite porphyroblasts on foliation plane.

MIDDLE TO LATE ORDOVICIAN

La Poile Group (6-7)

7 Georges Brook Formation: 7a, rhyolite, rhyolite tuff, lapilli tuff, crystal tuff, agglomerate, minor sedimentary rocks; 7b, mafic volcanic rocks including flows, pyroclastic rocks and dikes; 7c, lithic sandstone and conglomerate with dominantly volcanic clasts.

6 Hoti Granite: Equigranular, subvolcanic granodiorite to quartz porphyry.

Bay Du Nord Group (2-5)

5 Dolman Formation: Crystal tuff, lapilli tuff; massive gray, streaky, feldspathic schist.

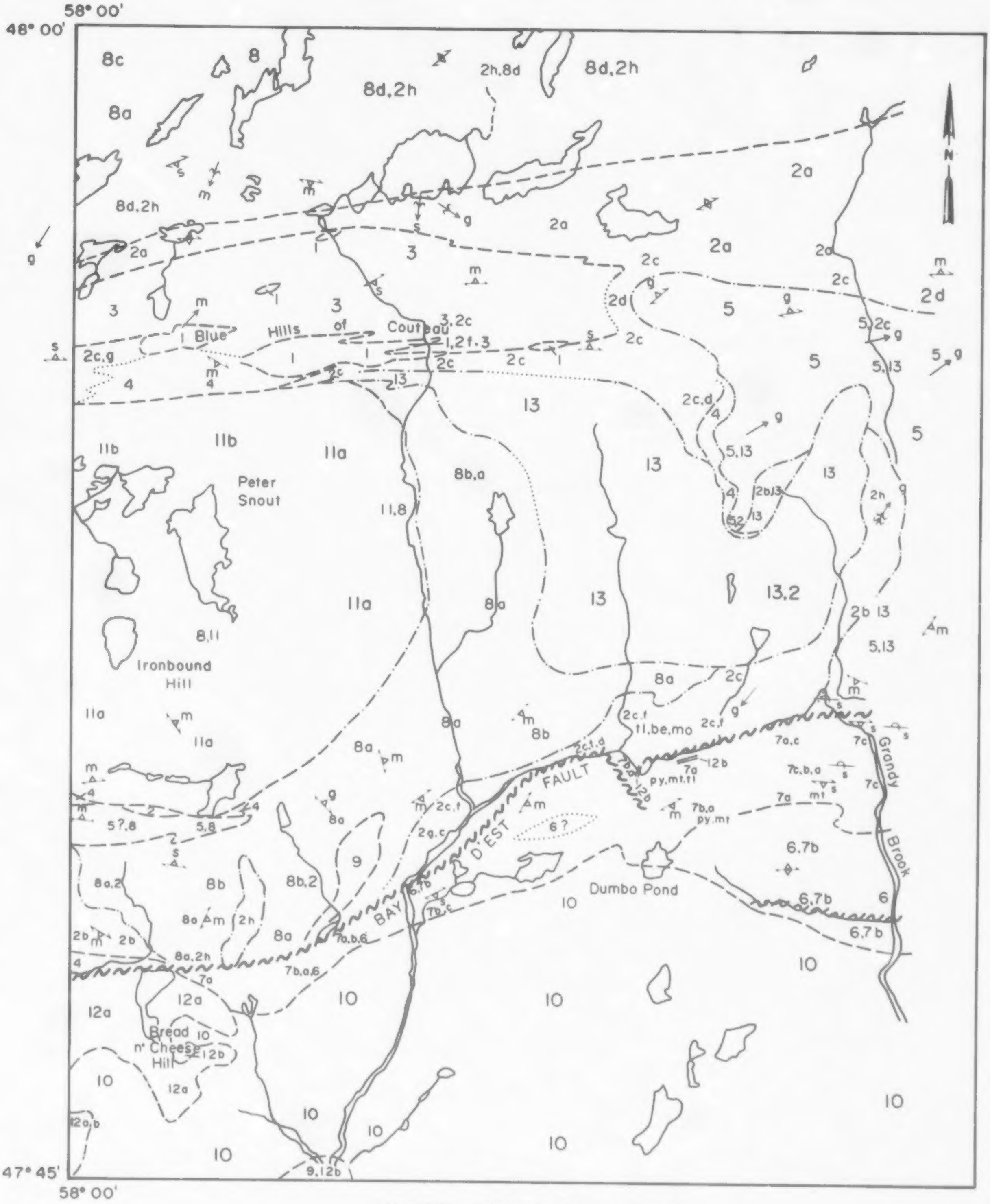
4 Piglet Brook Rhyolite: Pink rhyolite or rhyolite sills.

3 Baggs Hill Granite: Fine grained, subvolcanic granite, granophyre, quartz (feldspar) porphyry.

2 Metasedimentary and metavolcanic rocks: 2a, Dark phyllite with metagraywacke and graphite schist bands; 2b, metagraywacke, metasiltstone; 2c, silicic metavolcanic, including pyroclastic rocks, tuffaceous metagraywacke; 2d, white weathering rhyolite, rhyolite tuff; 2e, polymictic volcanic conglomerate;2f, mafic metavolcanic rocks; 2g, amphibolite; 2h, injection gneiss.

ORDOVICIAN? OR OLDER?

1 Metagabbro, layered metagabbro, metapyroxenite, metadiabase and volcanic rocks, genetically related amphibolite.


58° 00'
48° 00'
47° 45'
58° 00'
N
8c
8
8a
8d,2h
2h,8d
8d,2h
2a
3
Blue Hills of Couteau
3,2c
1,2f,3
2c,g
2c
2d
5
5,2c
5,13
5 g
4
13
11b
11a
Peter Snout
11,8
8b,a
2c,d
2b,13
13,2
2h
2b 13
8,11
Ironbound Hill
8a
2c
2c,f
tl,be,mo
8b
8a
FAULT
BAY D'EST
7a,c
7c
Grandy Brook
7c,b,a
py,mt,tl
12b
7b,a
py,mt
6?
5?,8
5,8
9
6,7b
Dumbo Pond
6
6,7b
10
8a,2
8b
8b,2
2h
2b
8a,2h
7a
7b,a,6
7a,b,6
12a
Bread n' Cheese Hill
12b
12a,b
9,12b
m
s
g

PETER SNOUT (west half)
11P/13 W

Kilometres 5 0 5 Kilometres

other metasedimentary rocks (2b) consist of garnet-biotite-quartz schist with thin bands of actinolite-epidote-quartz schist. Many outcrops contain thin migmatite stringers, and injections of Rose Blanche Granite and pegmatite. Similar rocks are found just west of Grandy Brook. where they are locally migmatized by the late granite (Unit 13).

Felsic volcaniclastic rocks (2c) are associated with amphibolite (2g) in the western and central parts of the map area, but with rhyolite and/or massive rhyolite tuff (2d) in the northeast. Exposures of polymictic, volcanic boulder conglomerate (2e) occupy an area adjacent to the Bay d'Est Fault, northeast of Dumbo Pond.

The felsic volcaniclastic rocks (2c) consist of interbedded lapilli tuff, agglomerate or conglomerate, and tuffaceous graywacke, with lenses of black laminated argillite. The lapilli tuffs grade into the agglomerate or conglomerate but the black argillite appears as discrete lenses. Clasts in the lapilli tuff consist mainly of rhyolite or fine grained granite with local concentrations of quartz and feldspar crystal fragments, and are enclosed in a gray biotite-rich matrix. The associated agglomerate/conglomerate contains moderately well sorted pebble to cobble sized clasts consisting largely of Baggs Hill Granite and Piglet rhyolite in complementary proportions. Mafic volcanic fragments occur locally with Piglet clasts around the Blue Hills of Couteau.

The massive rhyolite (2d) is a white to pale gray weathering, aphanitic felsite. It forms large outcrops on a hill overlooking the northwest branch of Grandy Brook, and occurs in proximity to felsic lapilli tuff, Piglet rhyolite, and Dolman tuff in a small range of hills to the southeast.

The polymictic conglomerate (2e) contains crudely sorted cobbles and boulders of quartz-feldspar porphyry, fine grained granite (Baggs Hill Granite), white rhyolite, vesicular basalt or andesite, diabase, and minor vein quartz. The fragments are elongated parallel to regional trends.

Mafic volcanic rocks (2f) are recognizable in the Blue Hills of Couteau, and near the Bay d'Est Fault. The Blue Hills exposures consist of basaltic breccias containing a few exotic quartz gabbro blocks, and veined with networks of white felsite. Lapilli tuff of intermediate to mafic composition was noted in this area. Near the Bay d'Est Fault, mafic volcanic boulders are fairly abundant in the polymictic volcanic conglomerate (2e). These boulders are buff to gray in color, and contain small ovoid biotite patches, presumably replacing former vesicle fillings. Several amphibolitized mafic dikes cut the conglomerate in this area.

Amphibolite (2g) occurs in association with the felsic volcanic rocks and as screens or inclusions within the Rose Blanche Granite. In the central part of the map area, amphibolite is interlayered with felsic pyroclastic rocks on a scale of ten centimetres to several metres. The amphibolite is composed mainly of hornblende and plagioclase, with traces of disseminated pyrite. A weak linear fabric is imparted by the hornblende crystals. Amphibolite xenoliths are common in the Rose Blanche granite to the north of these occurrences, and north of the Blue Hills of Couteau. Many of the amphibolitic rocks (2g) may be thoroughly reconstituted mafic volcanic rocks (2f), with original textures preserved only where sheltered from extreme deformation, for instance, within the Blue Hills gabbro boudins or by the presence of neighbouring felsic boulders. However, several amphibolite inliers of extremely basic composition in the northeast corner of the adjacent La Poile River area suggest that at least some of these rocks may represent reconstituted mafic and ultramafic plutonic rocks (1?).

Migmatite and injection gneiss (2h) occur as screens in the Rose Blanche Granite (8d) within a broad shear zone across the north side of the area, and also in the west and central parts. Most of these rocks are semipelitic biotite schist hosting stringers of white leucogranite and injections of Rose Blanche granite or granodiorite. Screens of more silicic rock occur within the northern shear zone, where they are difficult to separate from the enclosing granitoid material.

Baggs Hill Granite (Unit 3)

The Baggs Hill Granite (Cooper, 1954) is a subvolcanic granite which occupies a broad band through the Blue Hills of Couteau. The granite encloses and locally intrudes lenses or boudins of metagabbro but the contacts with the metasedimentary and metavolcanic rocks are not exposed in this map area. Fragments of the Baggs Hill Granite are common within the Bay du Nord pyroclastic rocks.

The granite forms hackly, cream colored outcrops, which range from moderately fine grained leucogranite to quartz and/or feldspar porphyry. Fine grained biotite aggregates are the only discernable ferromagnesian mineral phase. Rare, highly reddened patches in the granite contain relatively high concentrations of biotite.

Piglet Brook Rhyolite (Unit 4)

The name Piglet Brook Rhyolite (Chorlton, in preparation) is applied to a distinctive, equigranular, flesh-colored rhyolite, formerly referred to as 'granulite' by Cooper (1954) and pink rhyolite by Chorlton (1979a). Layers of this rhyolite are associated with the Bay du Nord metasedimentary and metavolcanic rocks in several places within the map area, and fragments of the rhyolite occur locally within the Bay du Nord volcanic conglomerate or agglomerate.

The Piglet Brook Rhyolite has a sugary texture, and forms smooth, commonly fractured outcrops. It is composed primarily of a fine grained intergrowth of quartz and feldspar with traces of muscovite, enclosing tiny phenocrysts of reddened plagioclase and rare, altered alkali feldspar. Garnet occurs in the rhyolite next to the Bay d'Est Fault. The matrix generally contains very fine grained brown specks, which probably represent a weathered oxide mineral.

Dolman formation (Unit 5)

The Dolman formation (Chorlton, 1978) consists of deformed and metamorphosed felsic volcanic rocks, mainly crystal-lithic tuff. It is thought to be younger than most of the Bay du Nord rocks in the area, and may possibly be equivalent to parts of the Georges Brook Formation (Chorlton, 1978). A zircon U/Pb radiometric date obtained from the tuff in the La Poile River map area yielded an age of 449 ± 20 Ma (Dallmeyer, unpublished report).

Primary textures such as thick beds and coarse volcanic clasts are preserved near Dolman Cove in the La Poile River area (Chorlton, in preparation) but were obliterated by deformation and recrystallization eastward toward the present area. The resultant schist is light gray to buff in color and monotonous in outcrop, with a pronounced linear fabric produced by the elongation of coarse biotite and feldspar clots.

La Poile Group (Units 6 and 7)

The La Poile Group originally defined by Cooper (1954) and redefined by Chorlton (1979b), is composed of three formations in the type area: the Roti Granite, the Georges Brook Formation, and the Hawks Nest Pond Porphyry. The latter is not exposed in the present area. The Roti Granite is a subvolcanic granite which was emplaced early in the depositional interval of the Georges Brook Formation, a thick assemblage of felsic and mafic volcanic rocks and associated sedimentary bands and lenses. The Hawks Nest Pond Porphyry is a porphyritic microgranite, intruded into the youngest deposits of the Georges Brook Formation. A tentative Rb/Sr whole rock isochron derived from mafic and felsic volcanic rocks of the Georges Brook Formation yielded an age of 459 ± 18 Ma (Wanless, personal communication). Another unpublished U/Pb zircon date on the Hawks Nest Pond Porphyry of 410 ± 20 Ma suggests that this phase may be significantly younger (Dallmeyer, unpublished report).

The La Poile Group has been polydeformed and metamorphosed to greenschist facies.

Roti Granite (Unit 6)

The Roti Granite (Cooper, 1954), a subvolcanic granite, occupies a wedge between Dumbo Pond and Grandy Brook and forms small lenses associated with mafic dikes to the west. The granite is intruded by the late, megacrystic granite (10) to the south, and is unconformably overlain by the Georges Brook bedded lapilli tuff, conglomerate, and sandstone to the north. The latter rocks contain clasts of Roti Granite. The granite is highly sheared and silicified near the northern contact and numerous rusty zones contain finely disseminated pyrite. Irregular mafic dikes cut both the Roti Granite and the Georges Brook Formation.

The granite varies from sugary felsite and sericite schist in highly sheared zones, to penetratively foliated quartz phyric granite. The quartz domains are flattened and the feldspar highly altered. Clots of biotite, epidote, chlorite and sphene constitute the main mafic phase. In the southeast, near the megacrystic granite contact and a prominent late shear zone, the quartz and ferromagnesian clots are elongated to form a steeply plunging linear fabric and the feldspars are pervasively reddened.

Georges Brook Formation (Unit 7)

The name Georges Brook Formation (Chorlton, 1979b) was given to a sequence of mafic and felsic volcanic and sedimentary rocks, which is best exposed in the La Poile area to the southwest. This unit underlies a strip across the present map area adjacent to the Bay d'Est Fault. It is intruded by the late red granite (12) and the megacrystic granite (10), by which it is thermally metamorphosed.

In this area, the Georges Brook Formation is represented by diabase, dominantly mafic agglomerate or conglomerate, and felsic volcanic rocks which pass eastward into massive and bedded lapilli tuff, crystal tuff, conglomerate, and sandstone near Grandy Brook. The mafic rocks west of Spumoni Pond are coarsely recrystallized by the megacrystic granite, contain relatively high proportions of biotite, and are veined with epidote. The associated conglomerate is also coarsely recrystallized; it contains more mafic than felsic fragments and some banded or laminated fragments were observed. The felsic rocks include both crystal tuff and fine grained, sugary felsite, which are cut by mafic dikes; all are very similar to Bay du Nord assemblage on the north side of the fault zone. This association extends to outcrop areas north and immediately northeast of Dumbo Pond, where the mafic and felsic volcanic rocks are locally highly sheared and mineralized with pyrite and magnetite. One small plug of fine grained gabbro was noted in this area.

Farther east, crystal and lapilli tuff, interbedded with conglomerate and sandstone are cut by mafic dikes. The tuffs contain mainly felsic fragments; however, the conglomerates contain pebble to boulder sized fragments of mafic volcanic rock, fine grained granite, quartz porphyry, rhyolite, and vein quartz in varying proportions. The sandstones are coarsely crossbedded graywacke and contain discontinuous pebble and granule lenses. The beds are steeply overturned and face north. Contact metamorphic effects are also present in this area; they include the development of andalusite in several pelitic lenses and of chlorite poikiloblasts in intermediate rocks on the hill west of Grandy Brook, and reaction rims around mafic cobbles in the conglomerates exposed in Grandy Brook. The felsic pyroclastic rocks host locally intense magnetite mineralization on the hill near the Roti Granite contact.

Rose Blanche Granite (Unit 8)

Rose Blanche Granite is the name applied by Brown (1976, 1977) to intrusions of variably deformed, equigranular biotite granite, granodiorite, and garnetiferous leucogranite which occur as sheets in the reworked Port aux Basques Gneiss. This unit extends across the La Poile River (110/16) map area into the northwestern part of Peter Snout area, and similar rock is exposed south of the Blue Hills of Couteau. The granites intrude amphibolite facies semipelitic and felsic schist, and amphibolite of the Bay du Nord Group, in which leucocratic stringers are common. The granite is itself cut after the main deformation by porphyritic monzodiorite and granodiorite (11), and equigranular granite (13). However, the positions of the contacts require further investigation.

The Rose Blanche Granite includes several texturally distinct phases. In the northwest corner, it is a white weathering, granodiorite or tonalite (8a) with subordinate pink granitic lenses (8c) characterized by segregated biotite lenses. A broad shear belt transects this lithology to the south-southeast, within which the granite and its inclusions are blastomylonitic (8d). Coarse grained and fine grained layers alternate, the micas are coarse grained and confined to discrete foliation planes, and the quartzofeldspathic minerals are flattened. In coarse grained layers, feldspar porphyroclasts form augen in the foliation. Large porphyroblasts of muscovite in the foliation planes are also characteristic of the granitic rocks in this belt. The rocks south of the Blue Hills of Couteau range from white weathering granodiorite (8a) to white or pink muscovite granite, with rare minute garnets (8b). They posses a foliation defined by the flattening of quartzofeldspathic aggregates and the subparallel orientation of the micas, but are not gneissic. Pegmatites with abundant garnet and less abundant tourmaline are common locally.

Otter Point Granite (Unit 9)

The Otter Point Granite (Chorlton, 1979b) is a large body of coarse grained porphyritic granite exposed along the south coast in the La Poile area. The intrusion extends into the southwest corner of the map area, where it is truncated by the late porphyritic granite (10). Small lenses of granitic augen schist are exposed within the Rose Blanche Granite terrane north of the Bay d'Est Fault and are only very tentatively correlated with this granite.

The granite contains large, twinned orthoclase/microcline and smaller plagioclase phenocrysts in a coarse grained matrix of quartz, biotite, and hornblende. The Otter Point Granite is distinct from the younger porphyritic granite in that it contains less ferromagnesian constituents, and that the biotite marks a weak schistosity that locally augen the feldspar phenocrysts. An abundance of sugary, pink to red aplite is associated with the Otter Point Granite.

Porphyritic, mafic-rich granite (Unit 10)

This large, unnamed granite body occupies the south part of the map area, and extends to the southeast at least as far as Burgeo. It cuts the Otter Point Granite and the La Poile Group, and is cut by the equigranular red granite and related dikes (12). Except for late shearing, the body is essentially undeformed, though it possesses a penetrative fabric near Burgeo.

Outcrops of this granite are large and rounded. Feldspar phenocrysts from 2 to 4 cm in diameter are visible from a distance. The phenocrysts consist of euhedral pink to white, patchy orthoclase and/or microcline with perthitic cores and tiny, zonally arranged plagioclase inclusions near the rims. The ferromagnesian minerals, mainly biotite, constitute about 15 to 20 per cent of the modal composition, and occur with plagioclase, microcline, quartz, and abundant accessory sphene in the matrix.

Porphyritic monzodiorite, granodiorite, and granite (Unit 11)

This suite underlies a roughly circular area around Ironbound Hill. It is intruded by the late, equigranular leucogranite (13), however, its relationship with the other units is still uncertain.

At least three phases of this body have been identified, but no contacts among them have been observed. The most mafic phase is a porphyritic monzodiorite to quartz monzonite, which weathers dark gray in outcrop. Gray, visibly zoned plagioclase tablets, some partly altered to microcline, are embedded in a coarse grained matrix of biotite, hornblende, augite, microcline, and quartz. It is apparently unfoliated. The most widely exposed phase is a porphyritic granodiorite, of which the chief distinguishing feature is the presence of plagioclase and smaller prismatic hornblende phenocrysts in a matrix of feldspar, quartz, biotite and amphibole. The ferromagnesian minerals define a foliation which is especially strong in the shear zone south of Ironbound Hill, and decreases in intensity northwards. The granitic phase is confined to a small area at the western margin of the map area. It is composed of large, ragged microcline phenocrysts or porphyroblasts which poikilitically enclose small grains of plagioclase, quartz and biotite set in a coarse grained granitic matrix.

Chetwynd Granite (Unit 12)

The Chetwynd Granite (Cooper, 1954) is a semicircular intrusion of medium grained pink biotite granite and associated porphyry dikes largely exposed in the La Poile (110/9) and La Poile River (110/16) map areas (Chorlton, 1979a, 1979b). It cuts the porphyritic, mafic-rich granite (10), the Otter Point Granite (9), and the La Poile Group (6,7). Several fine grained porphyritic apophyses attached to the main intrusion are identical to dikes (12b) which occur 10 km to the east-northeast. The presence of abundant pink aplite in the Bay d'Est Fault zone may possibly be linked to the emplacement of the Chetwynd Granite.

The granite is composed of red to pink perthitic microcline, plagioclase, quartz, and biotite, with accessory sphene, zircon, and iron oxide commonly visible in hand specimen. It varies widely in texture. Medium grained equigranular granite predominates, and grades internally into pockets of coarse grained microcline porphyritic granite, and into quartz and feldspar phyric microgranite near the eastern margin. The dikes contain phenocrysts of quartz and feldspar in a pink, granophyric matrix.

Late, equigranular biotite granite (Unit 13)

This granite forms another semicircular body in the east-central part of the map area, but appears to have extensive offshoots to the west. It cuts the Rose Blanche Granite and Bay du Nord Group after the second phase of regional deformation and creates local migmatite zones in the latter. A similar granite, the Spoon Brook Granite (Chorlton, in preparation), is exposed in the La Poile River (110/16) map area.

The granite weathers white to pale pink, but is locally mottled red and white. It consists of a medium to fine grained intergrowth of microcline, plagioclase, quartz, and biotite with minor muscovite and garnet.

Pegmatites and Veins

Pegmatite and tourmaline veins are concentrated around the Bay d'Est Fault zone. Pegmatites are also abundant in the shear zone south of Ironbound Hill.

The fault zone pegmatites and veins are hosted in sheared La Poile and Bay du Nord Group volcanic rocks. The pegmatites consists of graphic granite, quartz, tourmaline, accessory magnetite, and rare beryl. Tourmaline-quartz veins are ubiquitous in this zone, and contain minor sulphides. One network of tourmaline and graphic granite veins on the north side of the fault contains beryl, molybdenite, pyrite, chalcopyrite, and malachite. Purple and green fluorite occurs along the schistosity nearby.

The pegmatites south of Ironbound Hill are hosted by the Rose Blanche Granite and very deformed Dolman tuff. These pegmatites consist of microcline, albite, quartz, muscovite, garnet, and local tourmaline.

DEFORMATION AND METAMORPHISM

Units 1 through 7 have been subjected to four regional tectonic events, units 8 through 9 by three, and the units 10 through 13 by two.

The first event was followed by a regional metamorphic peak in the amphibolite facies for the terrane north of the Bay d'Est Fault, and greenschist facies south of the fault. Consequently the main evidence for the first deformation is a remnant early schistosity preserved in the cores of porphyroblasts and inclined to the external foliation in the semipelitic schists.

The second deformation resulted in tight to isoclinal folding and the formation of an intense regional schistosity and lineation. In this map area, second generation fold hinges were observed in the Bay d'Est Fault and to the north on hills overlooking Grandy Brook. Steeply plunging isoclines also occur within the northern shear zone.

The third deformation resulted in refolding, shearing, and faulting, thought to be related in part to the uplift of the Bay du Nord terrane on the Bay d'Est and related faults. Open refolding of the second schistosity and fold hinges in the southeast contrast with fairly tight, third phase folding about generally east trending axial planes and east-northeast trending shears found in the northern shear zone. Transposition of early schistosity and the development of thin shear zones are common over most of the area. Severe boudinaging of post second deformation pegmatites in the shear zone south of Ironbound Hill, and the development of the foliation in the southeast part of the porphyritic monzodiorite-granodiorite (Unit 11) were also probably due to this event.

The fourth event is less significant than the earlier ones. It gave rise to upright, open chevron and kink folds at high angles to the regional grain, and local, roughly north striking block or strike-slip faults. Widely spaced crenulation cleavage is well developed in some areas.

MINERALIZATION

The most promising metallic mineralization is hosted in the La Poile and Bay du Nord Group volcanic rocks, and is concentrated within the Bay d'Est Fault and along offshoots and synchronous shear zones to the southeast. Pyrite and magnetite are the main metallic minerals. Disseminated pyrite and pyrite segregations along shear surfaces occur in both the felsic volcanic rocks and the mafic dikes which cut them. Chalcopyrite, in addition, was noted in the dikes towards the west part of the main mineralized zone. Magnetite occurs mainly in the felsic rocks, accompanied by disseminated pyrite.

A notable occurrence of massive and disseminated magnetite is located on the hill to the southeast of these showings overlooking Grandy Brook. The magnetite is hosted by ashflow tuff of the Georges Brook Formation and appears to be replacing parts of the matrix. The magnetite occurs a few metres north of the sheared contact with the Roti Granite, which itself contains several rusty zones caused by local disseminations of fine grained pyrite.

Tourmaline veins are abundant within the fault zone, and are present, but less numerous to the southeast. One tourmaline vein, which cuts mafic and felsic volcanic rocks on a waterfall north of the main mineralized zone, contains beryl, molybdenite, malachite, pyrite and chalcopyrite. In the same outcrop, green and purple fluorite were noted in fractures along the schistosity.

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GRANDYS LAKE, WEST HALF (110/15)

by

Lesley Chorlton

Mapping on a 1:50,000 scale in the Grandys Lake area was initiated in mid-August, but only small segments of the area have been traversed. The project area lies to the southeast of the Long Range-Cabot Fault; 1:50,000 scale mapping of the Carboniferous terrain area northwest of the fault has been completed (Knight, 1975).

The map area is not accessible by road, although paths ascend the Long Range escarpment from Doyles and South Branch in the Codroy Valley; also, from the highway along the south coast.

The Grandys Lake area was included in a 1:250,000 scale helicopter reconnaissance and compilation map (Gillis, 1972). The map areas to the south (110/10) and southwest (110/11) have been mapped on a 1:50,000 scale (Brown, 1976, 1977).

GENERAL GEOLOGY

The upland area between the Long Range-Cabot Fault and the Cape Ray Fault is underlain by mafic, ultramafic, and subordinate semipelitic rocks cut by tonalitic and granitic rocks. The area southeast of the Cape Ray Fault is underlain by semipelitic and amphibolitic schist cut by granite, granodiorite, tonalite, quartz veins, and pegmatite. These two terranes, separated by the Cape Ray Fault, will be referred to in this report as the Long Range and Port aux Basques zones respectively. The younger Windsor Point Group, a bimodal volcanic and sedimentary assemblage, occurs along the fault zone.

Long Range Zone

The mafic and ultramafic rocks in this zone belong to the Long Range Mafic-Ultramafic Complex (1) (Brown, 1977). Layered and massive coarse grained metagabbro, metadiabase, and serpentinite with locally developed white felsite stringers were observed in the areas traversed this summer. This complex was intruded by equigranular tonalite (4) which contains abundant amphibolite screens and xenoliths away from the main mafic masses. Semipelitic garnet-biotite and biotite schist (3) near the western side of the project area was also cut by white tonalite and/or granodiorite and pink, gneissic granite (4). A highly deformed, porphyritic granite (6) was observed cutting the tonalite/amphibolite terrane. Red, equigranular, biotite granite (8a), similar to the Isles aux Morts Brook Granite (Brown, 1976), cuts all of the older rocks posttectonically, but is itself sheared and fractured along the Cape Ray Fault zone. Thin quartz-sanidine porphyry dykes (8b) cut the tonalite/amphibolite terrane posttectonicallly northwest of Grandys Lake.

Port aux Basques Zone

The semipelitic, pelitic, and amphibolitic schists (3) of this zone are lithologically correlative with components of the Bay du Nord Group in the La Poile River area (Chorlton, 1979); they are also compatible with the latter in structural and metamorphic history. For instance, coarse grained staurolite-garnet-biotite (±kyanite) schist and acicular amphibole-bearing feldspathic schist, occupying a belt along the south side of the Cape Ray Fault, occur in an analogous position in the La Poile River map area. Likewise, amphibolite is abundant south of this zone in both map areas. The rocks are pervasively intruded by both equigranular, pink, biotite to muscovite granite and equigranular, white tonalite to granodiorite (5), possible equivalents to the Port aux Basques Granite and the Rose Blanche Granite (Brown, 1976), respectively. These granitoid rocks are penetratively foliated, and minor folds of this foliation are common. Several thick, boudinaged quartz veins were developed along northeast-trending shear zones.

Windsor Point Group (Unit 7)

The Windsor Point Group was defined by Brown (1976, 1977) as a series of metasedimentary and metavolcanic rocks that overlies the Cape Ray Fault. It is exposed from Cape Ray in the Port aux Basques area to the centre of the present map area, where it is either pinched out or dies out along the fault southwest of Grandys Lake. Similar rocks reoccur in the fault zone to the east in the La Poile River area (Chorlton, 1979). A zone of mylonitization marks its contact with the rocks of the Port aux Basques zone to the south. The presence of Long Range zone granitoid fragments in Windsor Point Group conglomerates in the Port aux Basques area indicates that the sequence unconformably overlies at least the oldest Long Range zone rocks (Brown, 1977).

The Windsor Point Group is represented in the present map area by felsic and mafic volcanic rocks, and sedimentary rocks. The felsic volcanic rocks include quartz porphyry, aphyric rhyolite or rhyolite tuff, quartz crystal tuff, and siliceous ashflow tuff or agglomerate. A rhyolite band along the southern contact with the late, red, biotite granite (8a) is intensely silicified.The mafic volcanic rocks include mafic flows and/or dikes and mafic tuffs. Although the mafic flows are highly sheared in most places, carbonate-filled vesicles were recognized locally. Chlorite schists exposed in this area contain abundant carbonate and are thought to represent mafic tuffs. Mafic volcanic rocks along the southern contact of the Windsor Point Group are highly sheared by the fault; thus, they could be confused with mylonitized amphibolite from the Port aux Basques zone. The sedimentary rocks contain conglomerate, siltstone, and slate. The conglomerates contain fragments of volcanic rock, fine grained granite, and sedimentary rock. The siltstones are highly siliceous, and thickly bedded. They are associated with ashflow tuff. Slate occurs as interbeds in the conglomeratic and volcanic rocks.

DEFORMATION AND METAMORPHISM

The rocks in the Long Range and Port aux Basques zones have been deformed and regionally metamorphosed before the deposition of the Windsor Point Group. The Windsor Point Group has been deformed by late activity on the Cape Ray Fault.

In the Long Range zone, the semipelitic and some of the mafic units were regionally deformed and metamorphosed to amphibolite facies. However, much of the rock in the cores of large mafic and ultramafic masses were not affected by regional metamorphism, but locally display metamorphic features reminiscent of ocean floor metamorphism (J. Malpas and G. Dunning, personal communication). Internal deformation is taken up in faults and shear zones. Peripherally, the mafic rocks are intruded by tonalite and converted to amphibolite. Late cataclastic deformation, or deformation associated with retrogression, affects most of the rocks in this zone, and is probably related to late movement on the faults.

LEGEND

8 Equigranular, red biotite granite (ILES AUX MORTS BROOK GRANITE?); fine grained quartz-sanidine porphyry dikes.

7 WINDSOR POINT GROUP: Mafic volcanic rocks; chlorite/sericite/carbonate schist; rhyolite, rhyolite tuff; agglomerate, ashflow tuff, volcanic conglomerate; siltstone, mudstone.

6 CAPE RAY GRANITE?: Porphyritic granite, foliated.

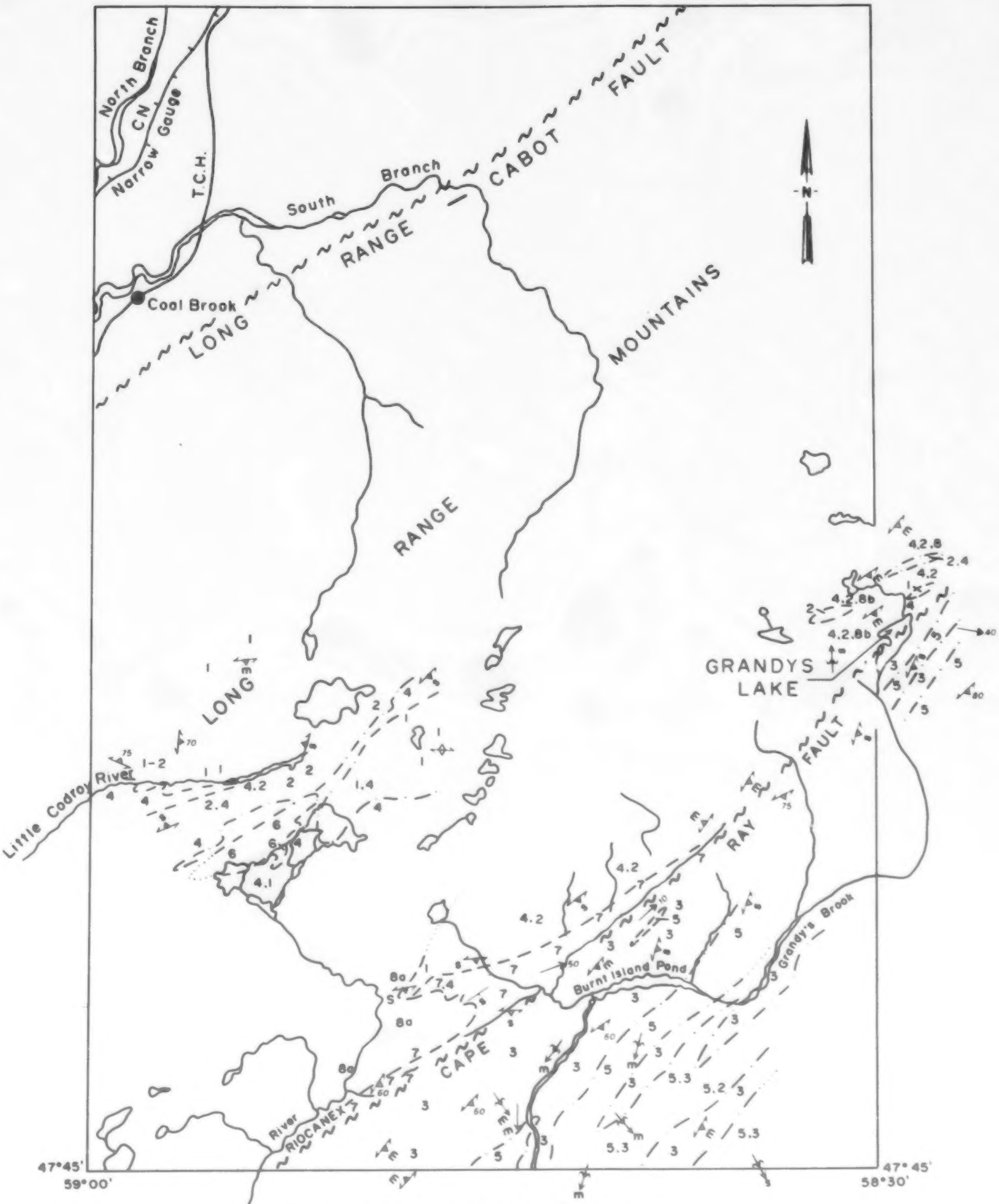
5 ROSE BLANCHE GRANITE - PORT AUX BASQUES GRANITE: Equigranular foliated granitoid rock with locally abundant inclusions; granodiorite, tonalite; (garnet)-muscovite-biotite granite; 5c, pink potassic biotite granite.

4 Long Range equigranular, foliated granitoid rock with locally abundant inclusions; granodiorite, tonalite; pink, potassic biotite granite.

3 BAY DU NORD GROUP - PORT AUX BASQUES GNEISS: Semipelitic and pelitic schist; amphibolite; injection gneiss; quartzite.

2 Long Range schists and gneisses: Semipelitic and pelitic schist, injection gneiss; amphibolite; impure carbonate/calc-silicate.

1 LONG RANGE MAFIC-ULTRAMAFIC COMPLEX: Massive and layered metagabbro; metadiabase, fine grained amphibolite; serpentinite, dunite.


North Branch
C.N.
Narrow Gauge
T.C.H.
South Branch
Coal Brook
LONG RANGE CABOT FAULT
LONG RANGE MOUNTAINS
N
RANGE
LONG
GRANDYS LAKE
Little Codroy River
Burnt Island Pond
Grandy's Brook
RAY FAULT
CAPE
RIOCANEX
River
Isles aux
47°45'
59°00'
47°45'
58°30'
1-2
4.2
2.4
1.4
4.1
4.2.8
4.2.8b
8a
7.4
5.3
5.2

GRANDYS LAKE, WEST HALF

(110, 15W)

Kilometres 5 0 5 Kilometres

In the Port aux Basques zone, all of the rocks mapped to date have been polydeformed and metamorphosed to amphibolite grade. Fresh mylonite zones are concentrated in and around the Cape Ray Fault zone; blastomylonite, possibly resulting from deformation related to the fault, occurs in a broader belt along the south side of the fault.

The Windsor Point Group has been metamorphosed to greenschist facies in the La Poile River area before deformation on the Cape Ray Fault (Chorlton, 1979), but its metamorphic history has not been established in the present area. Activity along the fault has resulted in zones of intense shearing, and kink or chevron folding in these rocks.

MINERALIZATION

The Riocanex gold prospect is located within the Cape Ray Fault zone near Isles aux Morts Brook, but was not examined this summer.

No notable mineralization has been yet found during this mapping project. All of the Windsor Point Group rocks contain low concentrations of disseminated pyrite. A sheared felsite or quartzite in the Port aux Basques zone contains pyritized shear zones at the outlet of Burnt Island Pond.

ACKNOWLEDGEMENTS

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THE SOUTHERN PORTION OF THE FLEUR DE LYS BELT ON THE BAIE VERTE PENINSULA
(12H/15E, 12H/10E, 12H9/W, 12H/7N)

by

J. HIBBARD, W. MUGGRIDGE, AND J. GAGNON

INTRODUCTION

Geologic mapping of the Fleur de Lys belt on the Baie Verte Peninsula at a scale of 1:50,000 was completed during the 1979 field season. The area surveyed included portions of the Jackson's Arm (12H/15E), Hampden (12H/10E), King's Point (12H/9W), and Sheffield Lake (12H/10N) map sheets. This part of the Baie Verte Peninsula is accessible by the Trans Canada Highway to the south, Baie Verte Highway to the east, Hampden road to the west, Bowater's logging roads in the areas of Wild Cove Pond and Black Lake, and by boat along the shores of White Bay. The west-central portion of the area was surveyed from three fly camps.

The area was previously mapped at a scale of 1:250,000 by Neale and Nash (1963). More detailed studies along the margins of the area have been carried out by Betz (1948) near Hampden, de Wit (1972) and Kidd (1974) to the north and northeast, and by Canadian Johns Mansville (Farquhar, 1959) and Brinex (Czamanske, 1956) to the southeast. The present study includes compilation and assessment of these investigations as well as mapping of intervening areas. All new informal stratigraphic names used in this report will be formalized in a forthcoming memoir on the geology of the Baie Verte Peninsula.

The rocks of the area compose the southern portion of the Fleur de Lys belt on the Baie Verte Peninsula. The Fleur de Lys belt forms the eastern margin to the Appalachian Humber Zone (Williams, 1978) and consists of polydeformed metasedimentary and metaigneous rocks intruded by postkinematic granitoid bodies. The belt extends from the Baie Verte Peninsula to the Grey Islands, more than 100 km to the north, and at least as far south as Grand Lake.

The Fleur de Lys belt within the present map area consists of the following three major geological elements; 1) the East Pond metamorphic suite (Hibbard, 1979), an intensly and inhomogeneously deformed unit of metasediments, banded gneisses and local eclogitic amphibolite pods, 2) the Fleur de Lys Supergroup, a thick sequence of polydeformed metasedimentary and metaigneous rocks, and 3) the Wild Cove Pond Igneous Complex, a composite granitic to dioritic pluton that intrudes both the East Pond metamorphic suite and Fleur de Lys Supergroup. These elements are bounded to the east by a discontinuous chain of ultramafic bodies that are remnants of a dismembered ophiolite termed the Advocate Complex (Williams, *et al.* 1977). The complex has been previously described (Hibbard, 1978) and is only briefly mentioned within this report. Isolated on Granby Island, to the west of the belt, graywacke and slate of the Granby Island formation may represent a less deformed and metamorphosed equivalent of parts of the Fleur de Lys Supergroup.

EAST POND METAMORPHIC SUITE (UNIT 1)

The East Pond metamorphic suite (Hibbard, 1979) consists of fine grained psammitic and semipelitic schists, amphibolite pods, and banded granodioritic gneisses that are poorly exposed in the north central portion of the map area. Migmatite and metaconglomerate that occur within the complex along strike to the north (Hibbard, 1979) do not appear to extend

LEGEND

SILURIAN TO DEVONIAN

WILD COVE POND IGNEOUS COMPLEX

7 granite, granodiorite, and diorite with minor pegmatitic and aplitic dikes.
7a - ultramafic xenoliths

EOCAMBRIAN TO ORDOVICIAN (?)

ADVOCATE COMPLEX

6 ultramafic fragments of an ophiolite

GRANBY ISLAND FORMATION

5 dominantly gray-black slate, argillite, and graywacke, minor boulder conglomerate

FLEUR DE LYS SUPERGROUP (2-4)

4 unseparated psammitic, semipelitic and graphitic schist and greenschist, includes rocks of Birchy Complex, Rattling Brook Group, and Old House Cove Group

WHITE BAY GROUP

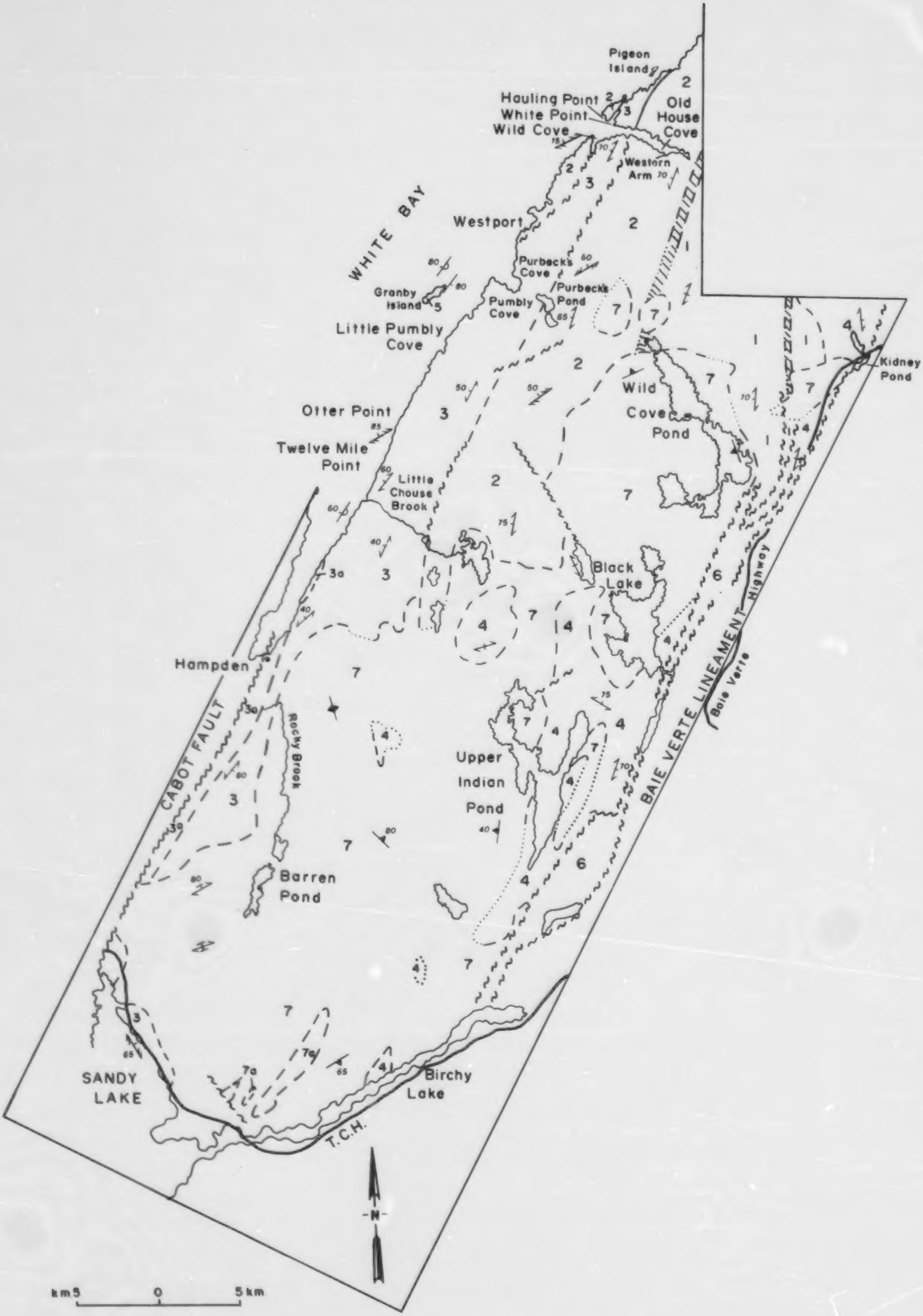
3 psammitic, semipelitic, and graphitic schist with amphibolite and marble interlayers
3a - *Oody Mountain amphibolite* with screens of Grenville (?) granitic gneiss.

OLD HOUSE COVE GROUP

2 psammitic and semipelitic schist with abundant amphibolite sills and dikes.

EAST POND METAMORPHIC SUITE

1 quartz-rich fine grained psammites and banded paragneisses; includes amphibolite pods that are locally eclogitic.


Pigeon Island
Hauling Point
White Point
Wild Cove
Old House Cove
Western Arm
WHITE BAY
Westport
Purbecks Cove
Purbecks Pond
Pumbly Cove
Granby Island
Little Pumbly Cove
Otter Point
Twelve Mile Point
Little Chouse Brook
Wild Cove Pond
Kidney Pond
Black Lake
Hampden
Rocky Brook
CABOT FAULT
BAIE VERTE LINEAMENT
Highway
Baie Verte
Upper Indian Pond
Barren Pond
SANDY LAKE
Birchy Lake
T.C.H.
N
km5
0
5km

into the map area. Outcrops of psammitic schist and gneiss are intimately comingled throuhout the present area, hence the gneisses may represent intensly deformed psammites. In eastern outcrop areas, exposures of coarse grained feldspathic psammite identical to those of the Old House Cove Group (Unit 2) are interspersed among typical fine grained, thinly layered East Pond psammite outcrops, and thus, are here included in the suite. This area may represent a transition zone between the two units, though very poor exposure precludes the interpretation of this transition as either tectonic (infolding or faulting) or depositional. To the west, the suite is in tectonic contact with the Old House Cove group along a wide high-strain zone delineated by feldspar porphyroblastic pelitic schist. A similar high-strain zone occurs within the suite near its eastern margin.

The age of the East Pond metamorphic suite is uncertain, though the unit has been interpreted as Grenvillian basement (de Wit, 1972) and more recently thought to range in age from Proterozoic to Lower Paleozoic (Hibbard, 1979).

FLEUR DE LYS SUPERGROUP (UNITS 2,3,4)

The Fleur de Lys Supergroup (Church, 1969) is a thick sequence of polydeformed metasedimentary and metaigneous rocks that is separated into three divisions in the area. The stratigraphic sequence of these rocks is uncertain, though contacts between units are all locally conformable. Previous correlations of the Fleur de Lys rocks with less deformed rocks of the Humber Zone (de Wit, 1972) as well as regional tectonic constraints (Bursnall and de Wit, 1975; Williams et al., 1977; Dallmeyer, 1977) indicate an Eocambrian to Lower Ordovician age for the supergroup. It may be partially correlative with the East Pond metamorphic suite (Hibbard, 1979).

Old House Cove Group (Unit 2)

Rocks previously assigned to the Seal Cove group (de Wit, 1972; Hibbard, 1979) are herein referred to as the Old House Cove group, as the term Seal Cove has been reserved for a stratigraphic unit elsewhere in Newfoundland. Psammites, semipelites, and amphibolites of the unit are well exposed at the new type section in Old House Cove, Western Arm. They form the lowest structural, if not stratigraphic, unit in the Fleur de Lys Supergroup.

The Old House Cove group outcrops in two belts; the main belt occupies the middle of the map area, whereas a thinner belt outcrops along the coast of White Bay, between Wild Cove Point and Westport. Typical rocks of the main outcrop belt have been described by Hibbard (1979) and the reader is referred to this report. The coastal section of the group bears an overall resemblance to the main outcrop belt, though it is generally more thinly layered, more graphitic, and has a greater proportion of mafic schist over the massive black amphibolite that is characteristic of the unit to the east.

De Wit (1972) defined a inlier of reconstituted Grenville basement within the coast belt near Hauling Point. These rocks are identical in field appearance to the surrounding Old House Cove group and hence, are not separated from them here.

The main outcrop belt of the Old House Cove group is in conformable, transitional contact with the White Bay Group (unit 3) in Western Arm. Near this contact, thin bands of garnetiferous quartz-muscovite semipelite are interlayered with typical Old House Cove psammite; the garnetiferous schist is continous along strike for nearly 20 km to the south. The contact between the Old House Cove coastal belt and the

White Bay Group is less clear. In the area between Westport and Purbeck's Cove, psammitic and semipelitic schist of the Old House Cove group subtly grade southward along strike through an intensely deformed and faulted zone into semipelite, graphitic schist, and quartz rich psammites of the White Bay Group; thus, this contact appears to be a faulted, laterally gradational contact.

White Bay Group (Unit 3)

The White Bay Group, first described by Betz (1948) in the Hampden area, is a varied assemblage of semipelite, graphitic schist, psammite, garnetiferous schist, amphibolite, marble, metaconglomerate, and quartzite. De Wit (1972) has defined seven formations in the Western Arm area, most of which cannot be reliably traced further south than Purbeck's Cove, though two of his units are recognizable as far south as Little Chouse Brook.

In Western Arm, carbonate schist, thinly layered quartzite, and marble form the structural base of the unit and are conformably overlain to the west by approximately 300 m of amphibolite. This asssociation extends as far south as Purbeck's Pond, south of which it appears to pinch out. At Western Arm, a thin unit of graphitic schist structurally overlies the amphibolite. This unit is structurally overlain by a thick sequence of infolded garnetiferous quartz-muscovite semipelite and magnetite bearing psammite that form an extensive belt from Pigeon Island, south to Little Chouse Brook. At Purbeck's Pond, where the graphitic schist unit is absent, the garnetiferous schist is interlayered with the amphibolite-marble association; south of here, the semipelite-psammite unit forms the eastern margin of the White Bay Group. South of Little Chouse Brook, quartz-muscovite semipelite, lacking garnet, extends along strike to the contact with the Wild Cove Pond Igneous Complex. The semipelite-psammite unit is in conformable contact with, and structurally overlain by, another amphibolite unit in Wild Cove; this mafic unit also extends only as far south as Purbeck's Pond before apparently pinching out. At Wild Cove, the amphibolite contains abundant flattened mafic clasts, strongly resembling a fragmental volcanic rock. This unit is faulted against the remainder of the White Bay Group to the west.

The western part of the White Bay Group, at White Point and from Purbeck's Cove south to Big Chouse Brook, is a heterogeneous assemblage of semipelite, graphitic schist, thinly layered quartz psammite, marble, carbonate schist, mafic schist, metaconglomerate, quartzite, and minor garnetiferous semipelite. Marble is the most conspicuous and variable rock type in this part of the group; it ranges in color from steel blue, to white and pink, and occurs as massive featureless layers,thinly laminated layers, carbonate breccias, zones of carbonate-muscovite schist, and as large (up to 15m) blocks within semipelitic and graphitic schist. On the coast between Little Pumbly Cove and Otter Point, layers of steel blue, white, and pink marble occur in close association with garnetiferous amphibolite and mafic schist layers. Quartz-rich psammite and quartz pebble metaconglomerate that locally exhibit graded bedding, are commonly interlayered with the marble. At the mouth of Little Chouse Brook within a section of east facing, overturned strata, a thick section of quartzite overlies a massive layer of marble; the quartzite pinches out abruptly along strike in both directions.

South of Big Chouse Brook, the White Bay Group is composed dominantly of fine grained biotite-quartz semipelite and graphitic schist with minor marble and quartz pebble metaconglomerate.

The *Oody Mountain amphibolite* (Unit 3a) forms the western boundary of the White Bay Group, against the Cabot

Fault. This thick amphibolite unit is conformably interlayered with metasediments of the group and, in many places, appears to display a primary diabasic texture. Along Rocky Brook and in the woods to the south, the amphibolite encloses large screens of foliated granitic gneiss; the foliation predates the deformation of the Oody Mountain amphibolite. The gneiss is very similar to Grenville gneiss of the Long Range Complex on the west side of White Bay. Northwards, along strike a single exposure of coarse metaconglomerate interlayered with the Oody Mountain amphibolite at the Beaches, contains cobbles of predeformed granite gneiss and quartzite. These relationships indicate that this zone likely marks an unonconformity between the Fleur de Lys supergroup and Grenville(?) basement; depending upon the original nature of the amphibolite, it may be either a nonconformity or an unconformity masked by intrusions of diabase.

UNSEPARATED FLEUR DE LYS ROCKS (UNIT 4)

Intensely deformed quartz-biotite semipelite, graphitic schist, garnetiferous semipelite, and amphibolite outcrop between the Baie Verte Lineament and the Wild Cove Pond Complex. The combined affects of the paucity of outcrop, strong deformation, and tectonism caused by the intrusion of the Wild Cove Pond Complex do not allow for the separation of these rocks at this time. Mafic schist and amphibolite are most obvious in the area east of the East Pond Complex and on Black Lake and Upper Indian Pond. Along the Baie Verte Highway, intensely deformed graphitic schist and quartz-biotite semipelite contain pods of actinolite schist up to 3 m in diameter. North of Kidney Pond, Kidd (1974) has reported a small, prekinematic granodiorite body.

Rocks in this zone are most likely correlative with the Rattling Brook Group and Birchy Complex that occur immediately north along strike. These units have been considered equivalent to the White Bay Group (de Wit, 1972).

STRATIGRAPHIC CONSIDERATIONS OF THE FLEUR DE LYS SUPERGROUP

The interpretation of an unconformity between the White Bay Group and Grenville basement near Hampden is not in accordance with earlier notions of Fleur de Lys stratigraphy. The structure of the Fleur de Lys belt has long been considered a simple anticlinorium, with oldest rocks in the centre of the area, succeeded outwards, towards the margin of the belt, by younger strata (*e.g.* Neale & Nash, 1963). De Wit (1972) considered rocks here included in the East Pond Complex as Grenville basement and considered the rocks of the present Old House Cove group to directly overlie basement. In turn, he considered these rocks to be overlain by the White Bay and Rattling Brook Groups. The present investigation indicates that to the southwest, the White Bay Group rests on basement without intervention of the thick, Old House Cove group.

These observations can be accomodated by at least two interpretations:

1) the Old House Cove and White Bay Groups are at least partial lateral equivalents representing different depositional facies resting on Grenville basement.

2) in the area of Hampden, the Old House Cove group was either eroded or never deposited before deposition of the White Bay Group.

In the present investigation, the first interpretation is favoured, as the one outcrop of metaconglomerate interlayered with the Oody Mountain amphibolite is very similar in aspect and clast content to metaconglomerate in the East Pond metamorphic suite. The latter unit surrounds a small body of migmatite which may be Grenville basement (de Wit, 1972; Hibbard, 1979). These metaconglomerates may be correlative and form a discontinuous marker horizon near the basement-cover contact. The contact of the White Bay and Old House Cove Groups near Westport also lends further support to this idea, as they appear to be laterally transitional.

GRANBY ISLAND FORMATION (UNIT 5)

The Granby Island formation is confined to Granby Island, White Bay. It is comprised of predominantly interlayered black to gray slates, argillites, and graywackes. The graywackes are commonly medium bedded, graded, and locally, are carbonate rich. On the southwest corner of the island, a coarse conglomeratic argillite with boulders greater than 1 m in diameter occurs at the strand line; all included clasts are indigenous to the formation.

The unit is substantially less deformed and metamorphosed than Fleur de Lys rocks to the east. Its age is uncertain, though the rocks are reminiscent of parts of the White Bay Group and may represent the protolith to parts of the group.

WILD COVE POND IGNEOUS COMPLEX (UNIT 7)

A large, composite granitic to dioritic pluton, the Wild Cove Pond Igneous Complex (Kidd, 1974), underlies approximately one half of the map area, extending south from Wild Cove Pond to Birchy Lake. Similar rocks may occur in the Kitty's Brook area, south of Sandy Lake (R. Taylor, pers. comm., 1979). The complex intrudes all of the metamorphic rocks in the area as well as ultramafic rocks of the Advocate Complex.

Rock types within the complex include biotite ± quartz ± hornblende diorite, hornblende ± quartz diorite, minor biotite-hornblende gabbro, biotite ± hornblende granodiorite, biotite granite, and biotite-muscovite granite. The highly variable distribution of these phases precludes their separation at the present scale, though biotite granite, the most common phase in the pluton, occupies a large area in the center of the pluton, west of Upper Indian Pond.

Dioritic rocks comprise the oldest phases of the complex, as they are either intruded by or included within all other phases. The diorites are common in the Wild Cove Pond and Black Lake areas, as well as in the area west of Barren Pond. The hornblende bearing phases are generally gray-green, equigranular fine to medium grained, and locally feldspar porphyritic. Minor feldspar porphyritic hornlende-biotite gabbro in the area immediately north of Birchy Lake is probably related to the diorites.

Biotite and biotite-hornblende granodiorite are commonly associated with the dioritic rocks. At most localities, irregular patches of medium to coarse grained granodiorite envelope the diorites, though west of Wild Cove Pond and west of Barren Pond, contacts between these rocks are gradational.

Medium to coarse grained, equigranular to feldspar porphyritic biotite granite is the most common rock type in the pluton. Along the north shore of Birchy Lake, large (up to 10 cm) megacrysts of potassium feldspar occur within the granite. Locally, the granite is in gradational contact with the granodiorite, though generally it intrudes all phases of the pluton except the two mica granite.

Fine to medium grained equigranular biotite-muscovite granite occurs as small irregularly distributed stocks throughout the complex; locally, it is garnetiferous. The best exposures of this granite occur immediately west of Upper Indian Pond and just north of Birchy Lake. Fine grained leucocratic dikes and aplite dikes that occur in the vicinity of these stocks are most likely related to the two mica granite. Muscovite bearing pegmatites that intrude all other phases of the pluton may also be another manifestation of the two mica granite.

The contact between the pluton and surrounding metamorphic rocks is very irregular and, in many places, transitional. In the areas of Black Lake, Upper Indian Pond and along the west edge of the pluton, large rafts of country rock are incorporated into the pluton, forming large scale agmatites; migmatitic hybrid gneisses are common in these areas. At the north end of Wild Cove Pond, a narrow zone of contact migmatite gneisses marks the edge of the pluton. Only at Rocky Brook and at the northeast corner of the granitic satellite at Kidney Pond, are the contacts with the country rock relatively sharp. Intermediate dikes that crosscut Fleur de Lys rocks along the Baie Verte highway and near Big Chouse Brook are believed to be associated with the complex.

Granitic rocks are seen in contact with ultramafic rocks of the Advocate Complex only east of Upper Indian Pond. The contact between feldspar porphyritic felsite and the ultramafic rocks is ambigiuous, as it is sheared and altered, but flecks of serpentine throughout the felsite strongly indicate an intrusive relationship here.

The complex encloses many map scale sized rafts of the country rock; their size indicates that they are most likely roof pendants in the pluton. Large xenoliths of ultramafic rocks and garnetiferous metagabbro occur immediately north of Birchy Lake. In hand specimen they appear to be totally recrystallized, and thus are not considered to be genetically related to the complex. Their proximity to, and similarity with ultramafic rocks along the Baie Verte Lineament implies they may be remnants of the Advocate Complex.

A K/Ar date on biotite from the granite at Wild Cove Pond has yielded an age of 358 m.y. (Neale and Nash, 1963). The complex postdates tectonism of the Fleur de Lys and East Pond rocks, which apparently ceased by the Middle Silurian (Dallmeyer 1977). Hence, the Wild Cove Pond Complex is considered to be Upper Silurian or Lower Devonian in age.

STRUCTURE AND METAMORPHISM

The structural and metamorphic histories of the East Pond metamorphic suite and Fleur de Lys Supergroup are very similar to those described by Bursnall (1979) and Hibbard (1979) for the same units on the northern part of the Baie Verte Peninsula. The reader is referred to these reports for general information.

The deformation and metamorphism of Fleur de Lys rocks in the area south of Big Chouse Brook is slightly different than that of the main Fleur de Lys outcrop belt. Here, recrystallization of the rocks is finer grained than elsewhere in the terrain, and the late deformation (D_L) and accompanying porphyroblast growth so prevalent elsewhere in the Fleur de Lys has had little affect. The change in structural-metamorphic character appears to be subtle and transitional.

The Wild Cove Pond Complex crosscuts and thus, post-dates most Fleur de Lys structures. At two localities along the west side of the pluton, fine grained granitic dikes have been affected by a late crenulation cleavage evident in the Fleur de Lys rocks. This late cleavage in the country rocks is local, and can not be directly correlated with other structures in the supergroup, hence the cleavage may be related to emplacement of the pluton.

All rock types within the complex are locally foliated. The foliation ranges from flow alignment of minerals to tectonic fabrics with flattened quartz and feldspar; many fabrics appear to be intermediate in character between these types. In the area west of Barren Pond, the granodiorite is gneissose, with wispy banding defined by biotite and hornblende. All of these structures postdate polydeformation and metamorphism of the country rocks and are considered to be related to the emplacement of the complex.

In the field, no thermal aureole was observed in the country rocks around the complex, though Kidd (1974) has defined an andalusite-cordierite aureole around the granite west of Kidney Pond, based on petrographic work. Coarse kyanite, presumably related to thermal metamorphism occurs in metasedimentary xenoliths near the south end of the complex.

ECONOMIC GEOLOGY

Mineralization in the area appears to be meager, minor galena occurs in small shear zones in the White Bay Group near Otter Point, and minor disseminated bornite was found in a marble boulder, near outcrop, at Purbeck's Cove. Hand samples of the two mica granite within the Wild Cove Pond Complex have yielded scintillometer readings 2 to 3 times greater than background.

Marble along the White Bay coast was at one time considered a prospect for facing stone, though generally it is highly fractured. Massive varieties do occur locally, and may be worthy of future investigation.

Rocks in Tennessee that are similar in aspect and tectonic setting to the Old House Cove group contain substantial massive sulfide deposits (Ducktown; Addy and Ypma, 1977); such a prospect is not to be discounted for the present field area.

ACKNOWLEDGEMENTS

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RECONNAISSANCE GEOLOGY OF THE WHITE BEAR RIVER (11P/14) AND DOLLAND BROOK (11P/15) MAP AREAS

by

W.R. Smyth

INTRODUCTION

The recently released 1:50,000 scale compilation maps of 11P/14 and 11P/15 (Smyth, 1979a) were spot checked during a ten-day period in August, 1979. Previous mapping at 1:63,360 scale was carried out by the Buchans Mining Company (Ledoux, 1957, and others) in the 1950's; these maps were available to Williams (1971) who produced a 1:250,000 scale map of the eastern half of the area. Riley (1959) produced a 1:253,440 map of the western half of the area.

The essential elements of the geology are a 10 km wide, roughly southeast-northwest trending belt of sedimentary, metasedimentary and minor silicic volcanic(?) rocks bounded to the north by a posttectonic megacrystic granite and to the south by a syntectonic megacrystic granite. The sedimentary belt terminates just east of Salmon River against highly deformed granite and gneiss. The belt continues westwards (Smyth, 1979a) and then southwestwards to the coast near La Poile where it has been subdivided into the La Poile Group and Bay du Nord Group (Cooper, 1954; Chorlton, 1979). To the east the belt is separated from the Ordovician Bay d'Espoir Group by 20 km of intervening granitoid rocks.

In the east of the map area, the metasedimentary belt can be subdivided into a southern belt of dominantly slates, argillites and probable silicic volcanic rocks in which metamorphic grade is lower greenschist facies and primary structures are preserved; and a northern belt of more highly deformed and metamorphosed slates and phyllites. In the west, this subdivision is not apparent and the sedimentary rocks show a southerly increase in deformation and metamorphism along the White Bear River (Smyth, 1979b). The ages of the sedimentary and volcanic(?) rocks are not known but are probably similar to the Bay du Nord Group to the west from which a U-Pb zircon age of 455 ± 15 Ma was recently determined (Dallmeyer, personal communication). The black graphitic slates in the metasedimentary terrain may represent the Caradocian sedimentary interval (D. Prince, personal communication) that is so well developd in central and northeastern Newfoundland (Dean, 1977).

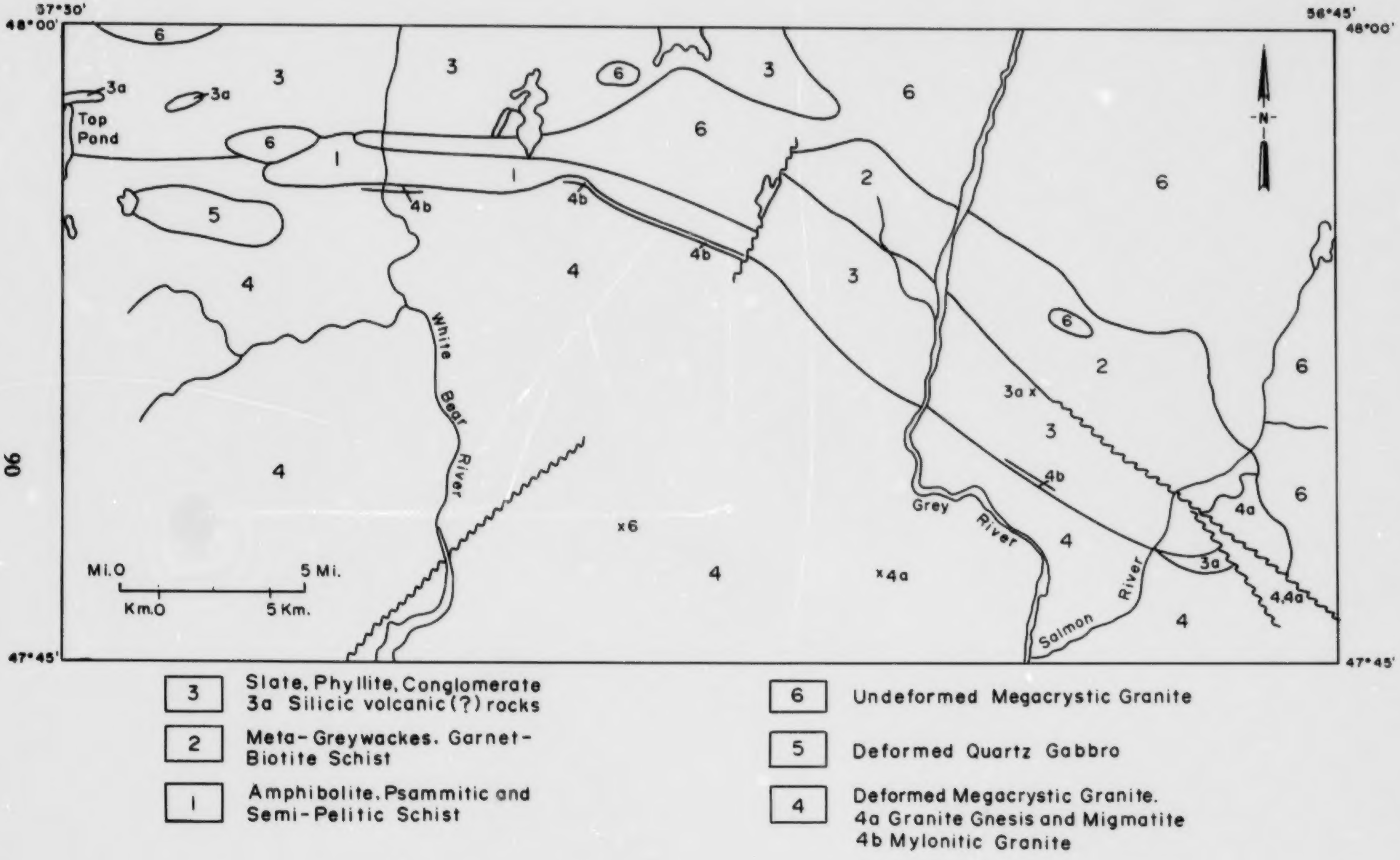
UNIT 1

Unit 1 consists of intermixed amphibolites, psammitic and semipelitic schists. It forms the most southerly exposures of the metasedimentary belt at White Bear River and extends up to 15 km to the east. The unit is extensively invaded by schistose granites and associated pegmatites, quartz veins and stringers. Locally, the metasediments have a migmatitic appearance.

The unit is bounded to the south by a mylonite which passes southwards into a megacrystic granite. Dikes of the megacrystic granite crosscut the main fabric of the schists, the schistose granites and early quartz veins.

UNIT 2

Unit 2 forms the northern part of the metasedimentary belt and consists mainly of psammitic and semipelitic schists metamorphosed to biotite grade or higher. Typical rock type is garnet-biotite schist. The belt passes southeastwards into a terrain dominated by deformed muscovite-garnet-leucogranites and orthogneisses. Locally, exposures of the metasediments in the


37°30'
48°00'
56°45'
48°00'
47°45'
47°45'
Top Pond
White Bear River
Grey River
Salmon River
-N-
Mi.0
5 Mi.
Km.0
5 Km.
1
2
3
3a
4
4a
4b
4,4a
5
6
3a x
x6
x4a
3 Slate, Phyllite, Conglomerate
3a Silicic volcanic(?) rocks
2 Meta-Greywackes, Garnet-Biotite Schist
1 Amphibolite, Psammitic and Semi-Pelitic Schist
6 Undeformed Megacrystic Granite
5 Deformed Quartz Gabbro
4 Deformed Megacrystic Granite.
4a Granite Gnesis and Migmatite
4b Mylonitic Granite

Salmon River contain up to 50% granite dikes and pegmatites. The granite dikes predate the main fabric (S_2) in the schists but in places can be seen to postdate the S_1 fabric. Xenoliths of paragneiss occur within the deformed granites.

The metamorphic grade of the metasediments decreases to the northwest into an area of poor exposure and the relationship with Unit 3 in this region was not determined.

UNIT 3

Unit 3 comprises the southern part of the metasedimentary belt in the Grey River - Salmon River area and consists of slates, phyllites, conglomerates and a possible extrusive silicic unit (Unit 3a). Similar low grade rocks (Unit 3b) also occur west of an intervening granite in the northwest of the area.

The most easterly rock type of the belt consists of a purple, aphanitic to finely crystalline, locally banded, siliceous igneous rock (Unit 3a). It was described as volcanic by Ledoux (1957) but similar rocks to the northwest of White Bear River are fine grained intrusives.

Pebble to cobble conglomerate (Unit 3b) outcrops in Salmon River and to the southeast. It contains up to 90% quartzite clasts with shale, sandstone and feldspar clasts making up the remainder. The conglomerates are clast supported and occur in beds up to 1 m thick interbedded with slates and phyllites. The source of the quartzite clasts is not known; however, extensive bands of quartzite occur 20 km to the south near the community of Grey River (Williams, 1971, Higgins and Smyth, this volume).

The predominant rock types of Unit 3 consist of black to dark gray slates, phyllites and argillites. Graphitic slates are present throughout the unit and are well exposed in a stream gully west of Grey River. They have a strong cleavage co-planar to bedding, that is folded about northerly inclined F_2 folds. The associated S_2 fabric is weakly developed. Locally, the F_2 folds are downward facing indicating that the early folds were flat lying.

UNIT 4

The metasedimentary belt is bounded on its southern margin by a deformed, coarse grained biotite granite with anhedral megacrysts of microcline and numerous associated pegmatites. Unit 4 appears to be an syn D_2 intrusion. Within Unit 4 small areas of granite gneiss and migmatite (Unit 4a) were noted. The gneiss appears to be gradational into deformed granite.

A mylonitic granite (Unit 4b) occurs at or close to the boundary between Unit 4 and the metasedimentary belt. In White Bear River, zones of mylonite can be seen to grade into the deformed megacrystic granite.

UNIT 5

Unit 5 consists of deformed coarse grained quartz gabbro with hornblende crystals up to 4 cm long. Its relationship to Unit 4 was not determined.

UNIT 6

Unit 6 consists of undeformed, porphyritic, biotite-hornblende granodiorite with associated aplite dikes and occurs predominantly to the north of the metasedimentary belt. It postdates the two deformations of the metasediments and intrusive contacts are common. Garnet-muscovite aplites are associated with Unit 6.

MINERALIZATION

A number of scheelite occurrences were discovered by the Buchans Mining Company at the contact of Unit 6 and Unit 2. These were not re-examined in this survey. Disseminated pyrite is common in the shales and pelitic schists.

ACKNOWLEDGEMENTS

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GEOLOGY OF THE GREY RIVER AREA - REGIONAL SUMMARY

by

N.C. Higgins* and W.R. Smyth

The Grey River area is underlain by a narrow east-west trending belt of metasedimentary, metavolcanic and gneissic rocks intruded and bounded to the north and south by granitoid rocks. An examination of the regional geology this summer revealed that the geology is more complex than previously described (Bahyrycz, 1957), with a number of tectonic and synkinematic intrusive events followed by a complicated postkinematic history of multiple intrusion.

The area is well known for its tungsten prospect (Fogwill, 1970), the mineralization being related to late quartz veins which are being investigated in a Ph.D. study by Higgins.

GENERAL GEOLOGY

The following sequence of geologic events has been determined from coastal exposures near Grey River Point and along the Grey River fiords as well as limited inland traverses.

Unit 1: Tonalite and granodiorite gneiss

The tonalite to granodiorite gneisses are light to dark gray, medium grained, well banded on a 1-2 cm scale with rare intrafolial folds. They consist largely of quartz, plagioclase, biotite and hornblende. They outcrop as screens between younger intrusions in the sea cliffs west of Grey River Point.

Unit 2a: Amphibolite

Minor blocks of medium grained, plagiophyric amphibolite occur within the tonalitic gneisses (Figure 1). The amphibolites either represent an earlier host to the tonalitic gneiss or disrupted dikes. In one locality an alignment of the amphibolitic blocks suggests that they were dikes.

Unit 2b, 2c: Quartz Diorite

The tonalitic gneisses are cut by medium grained quartz diorite sills and dikes that lack the gneissic banding characteristic of the tonalite gneiss although they are strongly foliated. A biotite-bearing phase and a hornblende-bearing phase can be distingished locally.

Unit 3a, 3b, 3c: Amphibolite and Micaceous Schist

Much of the Grey River area is underlain by coarse to medium grained amphibolites and micaceous schists metamorphosed in the epidote-amphibolite facies (Bahyrycz, 1957). The amphibolite protoliths were probably dominantly tuffaceous sediments but may include extrusive volcanic rocks. The amphibolites and the micaceous schists are interbanded on a gross scale and both are intruded by numerous thin dikes of pretectonic granite forming injection migmatites (Figure 1). Micaceous schist outcropping at the entrance to Southeast Arm have a strong, kinked schistosity that is locally overgrown by cordierite porphyroblasts. These may be related to the intrusion of a large K-feldspar megacrystic granite (Unit 6) that lies to the north of the metamorphic belt.

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LEGEND

DEVONIAN AND YOUNGER (?)

Posttectonic

10	Quartz veins
9	Diabase dikes
8	Aplites, garnetiferous leucogranite, alaskite, and pegmatite.
7b	Net-veined diorite
7a	Pegmatite, gray porphyritic granite

Late tectonic

6	K-feldspar megacrystic granite
5b	Amphibolitic dikes
5a	Ultramafic plugs

DEFORMATION AND MIGMATIZATION

DEVONIAN AND OLDER (?)

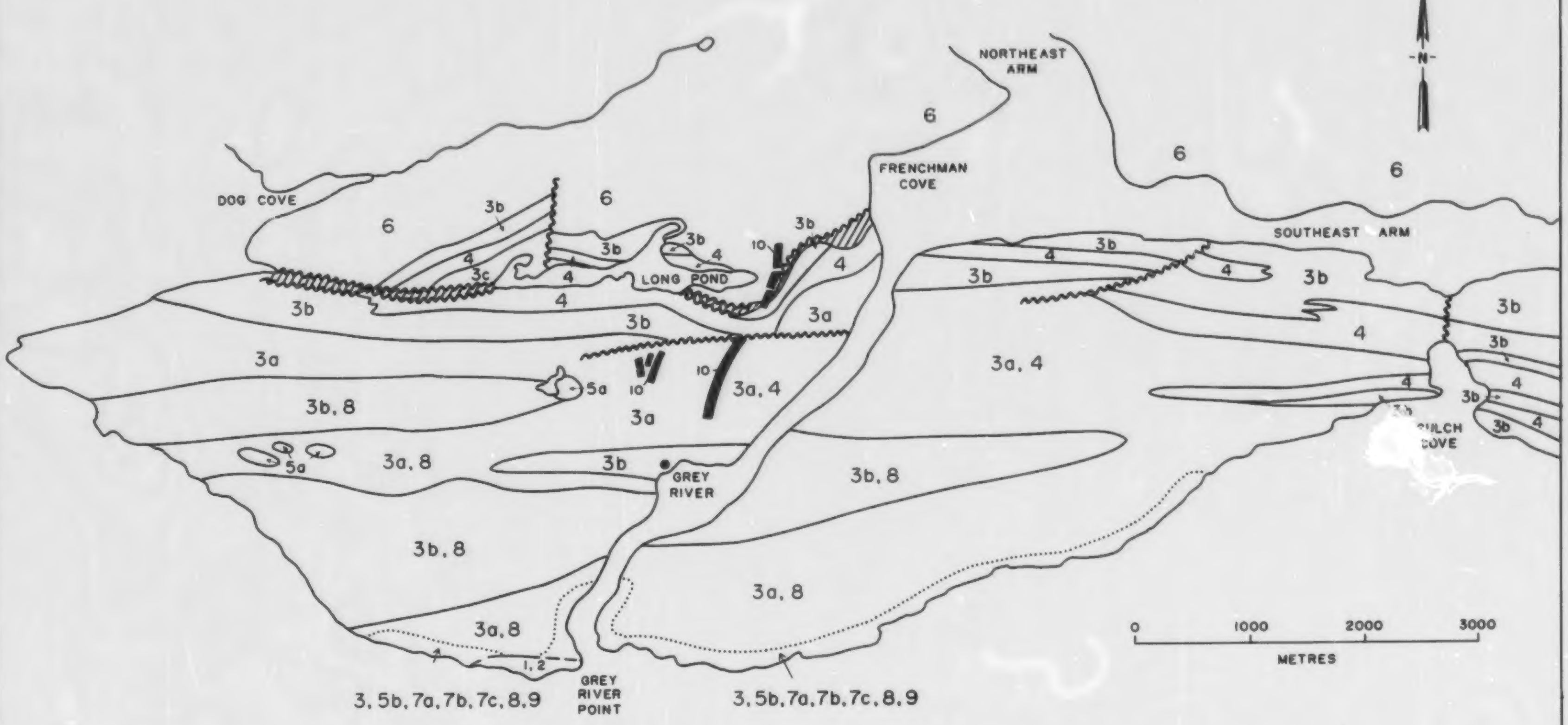
Pretectonic

4	Leucogranite
3c	Argillaceous marble and metaconglomerate
3b	Micaceous schist
3a	Amphibolite
2c	Biotite bearing quartz diorite
2a	Amphibolite dikes (?)

DEFORMATION

PRECAMBRIAN (?)

1	Intrusion of tonalite to granodiorite gneiss protolith


N
NORTHEAST ARM
FRENCHMAN COVE
DOG COVE
SOUTHEAST ARM
LONG POND
GREY RIVER
GREY RIVER POINT
ULCH COVE
6
3b
3c
3a
4
3a, 4
3b, 8
3a, 8
5a
10
1, 2
3, 5b, 7a, 7b, 7c, 8, 9
0
1000
2000
3000
METRES

Simplified Geological Map of The Grey River Area, Modified after Bahyrycz (1957)

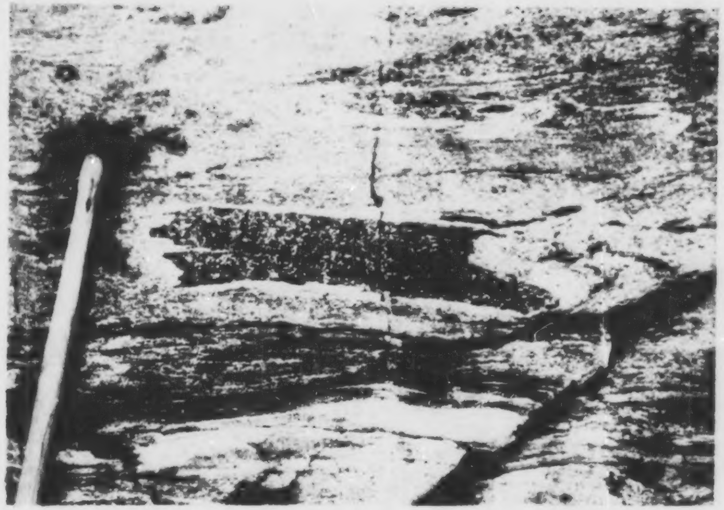


Figure 1. *Plagiophyric amphibolite block in banded tonalite gneiss. The amphibolite may be either a xenolith or a disrupted dike. West of Grey River Point.*

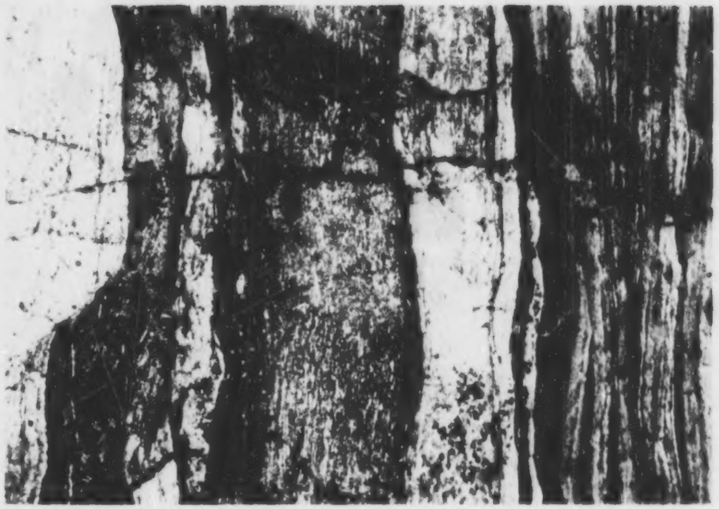


Figure 2. *Banded amphibolites with thin injections of pretectonic granite cut by thicker leucocratic granite sheets that crosscut the early foliation and granite. Coast north of Grey River.*

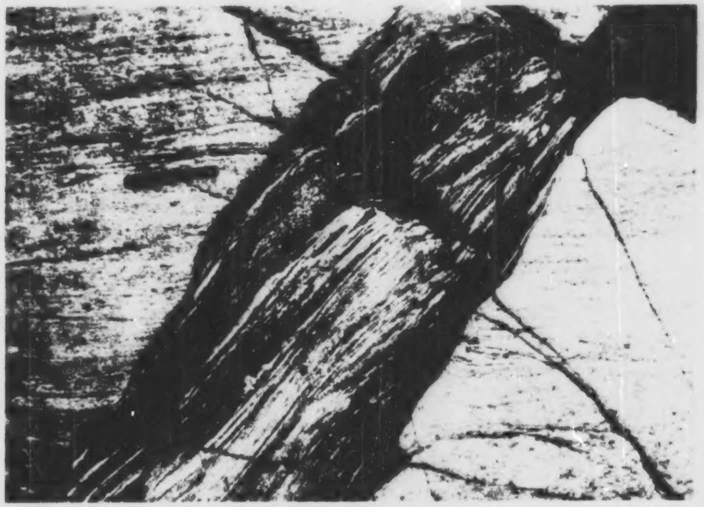


Figure 3. *Foliated amphibolite dikes crosscutting banding in tonalite gneiss. The dike was intruded in an active transcurrent fissure. Coast west of Grey River Point.*

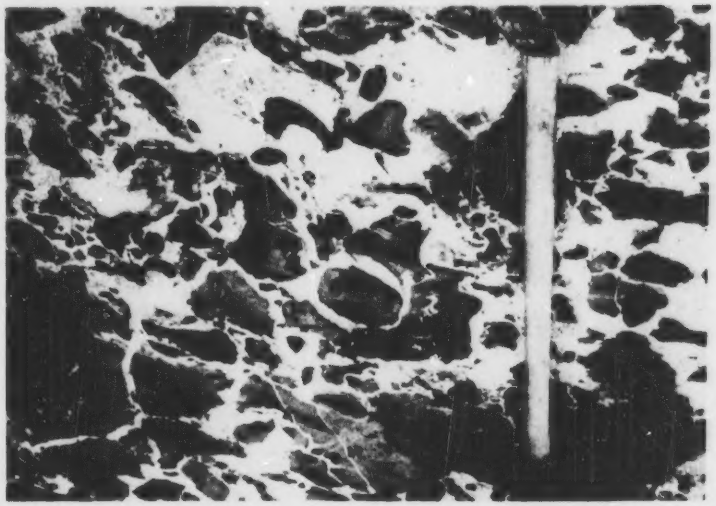


Figure 4. *Net veined diorite dike with granite veins dividing the diorite into irregular fragments. Coast west of Grey River Point.*

North of Long Pond and a major zone of cataclasis, the metamorphic rocks include schistose limy argillites and metaconglomerates (Unit 3c). The conglomerate contains granite and rhyolite clasts and its relationship to the metasedimentary rocks to the south is unknown.

Unit 4: Leucogranite

The migmatites of Units 3a, 3b are cut by leucogranite sills and dikes. The leucogranites are themselves foliated and generally parallel with the migmatitic banding. Locally, however, they diverge from the banding. The leucogranites, which continue eastwards at least as far as Gulch Cove, were incorrectly interpreted by Bahyrycz (1957) to be quartzites of sedimentary origin. It is possible that many of the other banded quartzites in the Grey River - Cape La Hune area (Williams, 1971; Butler & Greene, 1976) may also be of igneous origin.

A period of intense deformation followed the intrusion of the leucogranites and resulted in a strong fabric development in all previously described units.

Unit 5a, 5b

Late in the deformational episode a series of small (100-200 m wide) plugs of ultramafic rocks were intruded into migmatized sediments of Unit 3a and 3b. The deformation fabric in the margins of the plugs is parallel with that in the country rocks but dies out towards the centre of the bodies.

The plugs consist of very coarse dunite displaying a well preserved cumulative texture; serpentized olivine embayed by clinopyroxene and orthopyroxene forms the intercumulus phase. Low grade metamorphic minerals such as talc, chlorite, and muscovite are superimposed on the fabric.

Proabably at the same time as intrusion of the ultramafic plugs, a series of mafic to intermediate dikes (5b) were injected into active sinistral shear zones in the tonalitic gneisses (Unit 1) and quartz diorites. The dikes are strongly foliated and the foliation is slightly divergent to the orientation of the dike walls (Figure 3).

Unit 6: K-feldspar megacrystic granite

A large pluton of K-feldspar megacrystic, biotite rich granite forms the northern boundary of the metamorphic belt (3a, b). The granite is undeformed to moderately foliated and probably postdates the major deformation episode. The granite contains K-feldspar megacrysts up to 3 cm long that locally have plagioclase mantles. Often the megacrysts are aligned but their direction varies suggesting primary flow rather than a metamorphic alignment. The granite is contaminated in the contact zone by ingestion of country rocks. Strong cataclastic deformation is developed in the granite where a major mylonite zone is localized close to the contact with the country rocks. This intense cataclasis, well exposed at Frenchman Cove, dies out to the north.

Unit 7a, 7b, 7c

At the southern coastal exposures a number of posttectonic intrusive events are recognized and locally up to 70 percent of the outcrop consists of granite dikes and pegmatite.

The earliest are coarse, red, pegmatite dikes (7a) which are often intruded up their centres by spectacular dikes of net-veined diorite (7b) consisting of diorite fragments from cobble to block size surrounded by veins of gray porphyritic granite (Figure 4). The pegmatites and diorites were probably intruded contemporaneously, with the network of granite veins being derived from the pegmatites.

Unit 8

Aplite, alaskite, pegmatite and garnetiferous granite dikes were emplaced after the intrusion breccias. In the cliffs above Grey River Point the granitic material makes up 100 percent of the outcrop and defines a small stock. The frequency of dikes decreases away from this body.

Unit 9: Diabase dikes

The last intrusive event recognized consists of dark gray to green diabase dikes which cut all the earlier phases. These dikes are sometimes porphyritic with pyroxene and plagioclase phenocrysts.

Unit 10

Wolframite and scheelite occur within a hydrothermal quartz-vein system. The veins occupy fissures formed by a conjugate system of normal faults, which cut all of the above units. Other ore minerals include pyrite, chalcopyrite, molybdenite, bismuthinite, bismuth and marcasite. Fluorite and calcite occur as gangue minerals along with quartz. The vein system was offset by several east-west normal faults, and later was cut by a series of tensional veins containing fluorite, calcite, barite, sphalerite, galena, apophyllite and harmotome.

CONCLUSIONS

The tonalite and granodiorite gneiss (Unit 1) may be correlated with the Little Passage Gneiss (Colman-Sadd, 1974) exposed on Long Island, Bay d'Espoir. Based on concepts developed elsewhere in the Gander Zone (Kennedy and McGonigal, 1972; Colman-Sadd, 1974; Kennedy 1976), these gneisses may represent pre-Appalachian basement rocks, although these interpretations have recently been challenged by Blackwood (1978) and others.

It is not known whether the quartz diorites (Unit 2) that cut the tonalite gneiss are the same intrusions which form the injection migmatites in the amphiolites and micaceous schists (Unit 3). Also the age of these metasedimentary rocks is not known. The nearest dated metasedimentary and metavolcanic rocks are the Ordovician Baie d'Espoir Group to the east, but this group lacks the extensive migmatization characteristic of the Grey River area.

The amphibolites and mica schists of Unit 3 are texturally and lithologically similar to parts of the undated Port aux Basques Gneiss (Brown, 1976) to the west. This unit was considered to be Precambrian by Brown (1976) but this is questioned by Chorlton (personal communication) on the basis of work to the east. Samples of the Port aux Basques Granite (Brown, 1976), a synkinematic intrusion into the gneiss, were collected for U-Pb dating. These results may indirectly help solve some of the many problems of the geology of the Grey River area.

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ECONOMIC GEOLOGY OF THE EASTERN HERMITAGE FLEXURE

by
S. SWINDEN

INTRODUCTION

This report summarizes the intitial results of a project designed to investigate the regional geology and mineral deposits of the Hermitage flexure. The objectives of this study are to classify the various mineral deposits in the area, evaluate their economic significance in terms of the regional geology and provide a model of metallogeny throughout the flexure that wil prove useful in the search for economic mineral deposits.

Work during the 1979 field season was centered in the Bay d'Espoir area where numerous mineral occurrences have previously been reported (Douglas and Hsu, 1976) and where recent mapping by Colman-Sadd (1974, 1976), Colman-Sadd *et al.* (1979) and Falconbridge Nickel Mines Staff (1976) has provided a geologic framework for evaluating the significance of the various occurrences. Of central interest in this area was the Isle Galet Formation, a volcano-sedimentary sequence which forms the eastern limit of the Ordovician Baie d'Espoir Group. In this unit, rhyolitic flows, ash flows and pyroclastics and minor mafic volcanic rocks are interbedded with a variety of pelitic schists, psammitic and conglomeratic tuffaceous sediments and graphitic schists along a strike length in excess of 100 km. A number of mineral occurrences have previously been reported from this unit (Douglas and Hsu, 1976) and particular emphasis was placed on evaluating their significance with respect to regional volcanic stratigraphy in the Isle Galet Formation.

In addition, numerous showings of molybdenite, galena, pyrite, arsenopyrite and stibnite have been reported from other levels of the Baie d'Espoir Group and most of these were visited during the course of the program.

Both the Isle Galet Formation and the adjacent Riches Island Formation of the Baie d'Espoir Group were found to be host to a number of apparently stratabound sulfide occurrences, which appear to be synvolcanic in origin. In addition, epigenetic deposits of molybdenite, galena, barite, stibnite and associated metallic minerals are present which are probably related to the intrusion of nearby granites.

GENERAL GEOLOGY

The regional geology of the Baie d'Espoir area has previously been described by Colman-Sadd (1974, 1976, 1978). It is most conveniently considered in terms of three major components, *viz;* the Precambrian (?) Little Passage Gneisses and equivalents, sedimentary and volcanic rocks of the Ordovician Baie d'Espoir Group, and various granitoid intrusive rocks of early to mid-Paleozoic age.

The oldest rocks of the Bay d'Espoir area are dominantly psammitic to semipelitic gneisses assigned to the Little Passage Gneisses in southern Bay d'Espoir (Colman-Sadd, 1974) and unnamed elsewhere. They include lesser amounts of amphibolitic and tonalitic gneiss, were deformed prior to deposition of the Baie d'Espoir Group and are suggested by Colman-Sadd (in press) to be of late Precambrian to early Paleozoic age.

The gneissic rocks are overlain by metasedimentary and metavolcanic rocks of the Baie d'Espoir Group. The contact is commonly a thrust fault (the Day Cove Thrust of Colman-Sadd, 1974, 1976) which has been traced from southwestern Bay d'Espoir to the eastern edge of the St. Alban's map area. The Baie d'Espoir Group has been divided into five formations, three of which (the North Steady Pond, St. Joseph's Cove and Salmon River Dam Formations) display features characteristic of turbidite deposits (Colman-Sadd, 1976, 1979). Sediments of the two most southeasterly formations, the Riches Island and Isle Galet Formations, do not show evidence of turbidite deposition, the former comprising mainly green-gray pelite with minor interbedded siltstone and the latter consisting of dominantly green to gray pelite, tuffaceous graywacke and conglomerate and graphitic schist. Pebble lithologies in the graywacke and conglomerate are both volcanic and gneissic suggesting derivation from both the volcanic rocks of the Isle Galet Formation and from the deformed terrain to the southeast. The Isle Galet Formation contains considerable amounts of volcanic rocks, generally felsic in composition, which are described more fully below. Minor amounts of intermediate to felsic tuffs and flows are present within the Riches Island Formation and a single major felsic pyroclastic unit is found within the St. Joseph's Cove Formation. This latter unit is termed the Twillick Brook Member (Colman-Sadd, 1979) and appears to be a large ash flow which can be traced from near Twillick Brook on the Bay d'Espoir highway to east of Kepenkeck Lake over 60 km to the northeast.

A variety of plutonic granitoid rocks are present in the area. North of Lampidoes Passage, the North Bay Granite, a locally garnetiferous leucocratic granite, intrudes the Baie d'Espoir Group. Aplites, pegmatites and quartz veins near the margin of this granite are locally mineralized with pyrite, molybdenite and beryl. The Little Passage Gneisses in southern Bay d'Espoir are cut by a variety of plutonic rocks ranging from tonalite to megacrystic biotite granite and garnetiferous muscovite granite. These granites have not been seen cutting the Baie d'Espoir Group. Northeast of Bay d'Espoir, Little Passage Gneiss equivalents and the Baie d'Espoir Group are cut by granitoid rocks of the Ackley Granite and adjacent older granitoid intrusions (Dickson *et al.*, this volume).

THE ISLE GALET FORMATION

The Isle Galet Formation contains the bulk of the volcanic rocks found within the Baie d'Espoir Group and as such is a potential host for volcanogenic massive sulfide deposits. Considerable time during the present program was spent in an attempt to interpret the relationship between known mineral occurrences in this unit and its volcanic stratigraphy; the objectives were to determine which of these occurrences were synvolcanic and to identify favourable environments for further massive sulfide deposition. In doing this, the formation was traced beyond its previously mapped extent (Colman-Sadd, 1974, 1976) west to the area of Facheux Bay and northest to Kaegudeck Lake.

Three distinct volcanic facies, which are mutually gradational and which appear to represent variations in water depth and proximity to centers of volcanic activity, are developed in the Isle Galet Formation. These are herein termed the western, central and eastern facies.

The western facies is developed between Lampidoes Passage and the termination of the Baie d'Espoir Group west of Facheux Bay. Its volcanic component comprises more than 50% of the section and includes an extensive unit up to 1.5 km thick of massive to quartz-feldspar porphyritic ash flows and some probable rhyolitic flows interbedded with fine grained felsic tuff and quartz-crystal tuff. Associated sediments include gray to green pelite and psammite (tuffaceous graywacke) and a few lenses of pebbly conglomerate, the

clasts of which are dominantly volcanically derived. No coarse pyroclastic rocks or other evidence of proximal volcanic activity were noted and the environment is interpreted to be one which was moderately distal to a center of dominantly rhyolitic volcanism.

The central facies, which is developed between the western end of Bois Island and the area immediately northeast of River Pond, generally contains less than 30% volcanic rocks in the section. The transition between the western and central facies across Lampidoes Passage is quite abrupt suggesting that the change represents in part a major structural discontinuity. Rhyolitic flows and ash flows are essentially absent and their place in the stratigraphy is occupied by quartz-crystal felsic tuffs and fine grained felsic tuffs. A proportionally greater part of the section is occupied by green and gray pelitic rocks and by thick lenses of water-lain tuffaceous graywacke and conglomerate. Graphitic schist is common throughout the section. This facies appears to represent a more basinal environment than its western equivalents, and is considered to have been farther removed from the centers of volcanism.

The boundary between the central and eastern facies is extremely gradational with the latter facies becoming gradually more developed to the northeast. The transition starts in the area of the Harbour Breton Highway and is essentially complete in the area northwest of Medonnigonix Lake. Mafic volcanic rocks are more prevalent in this region and a few outcrops of poorly-preserved pillow lava were noted as were several outcrops of massive amphibolite which appear to represent mafic flows. The nature of the associated sedimentary rocks changes to the northeast with rhythmically bedded turbidites becoming interbedded with the volcanics at Kim Lake and giving way to mainly massive micaceous graywacke northwest of Kaegudeck Lake. Graphitic schist, which is characteristic of the sequences to the south and west, is essentially absent in this area. A unit of red to purple mudstone and pink arkose outcrops in a belt up to 400 m wide south and east of Kim Lake and several lenses of very coarse grained, immature volcanic conglomerate are present in the upper parts of the sequence. A thick (maximum 500 m) unit of rhyolite flows, ash flows, volcanic breccia and conglomerate, can be traced from the vicinity of the Harbour Breton highway northeast to near Kaegudeck Lake. At its extremities, this unit comprises massive rhyolite and fine grained tuffs but in its central portions northwest of Medonnigonix Lake, considerable volumes of volcanic breccia and volcanically-derived conglomerate are present, suggesting relative proximity to a volcanic center. Northwest of River Pond, the complex is intruded by a highly chloritized, deformed granite which appears to be a roughly conformable body approximately 5 km by 500 m and which may be related to the volcanic activity.

All of the above features are suggestive of a relatively more proximal volcanic environment than those to the southwest, characterized by abnormal amounts (for the Isle Galet Formation) of mafic volcanics, explosive volcanic activity, shallower water sedimentation, and areas of higher relief.

VOLCANOGENIC SULFIDE OCCURRENCES IN THE BAIE D'ESPOIR GROUP

Both the central and western facies of the Isle Galet Formation are host to base metal prospects, none of which is presently known to be of economic proportions. The best known of these, the Barasway de Cerf prospect, occurs in the central facies in southeastern Bay d'Espoir and has previously been described by Jewell (1939) and Doiron (1979). It comprises two stratabound horizons of argentiferous pyrite-galena-sphalerite mineralization which are 15 to 40 cm wide and separated by approximately 15 m of barren to sparsely mineralized rock (Figure 2). The mineralization occurs within a dominantly graphitic schist unit which forms part of an overall sequence of felsic to mafic tuff, pelite, tuffaceous graywacke and graphitic schist of the central facies. In detail, both horizons are seen to lie at the top of thin felsic tuff units within the shale sequence with the mineralization being dominantly within but not restricted to the felsic tuff. The mineralized zone can be traced on the ground along a strike length in excess of 1.5 km, is demonstrably stratabound and probably represents a fairly distal example of synvolcanic exhalative sulfide deposition.

An exhalative pyritic horizon outcrops in the bed of Collins Brook approximately 9.8 km northeast of Barasway de Cerf and at about the same stratigraphic level as the previously described occurrence. It ranges from 1.6 to 5 m in thickness and consists of a number of massive pyrite beds carrying minor disseminated chalcopyrite and sphalerite within an altered silicic tuff unit. The mineralized silicic tuff is interbedded with amphibolitic mafic tuff and is overlain by dark gray graphitic schist.

Two minor sulfide occurrences are hosted by felsic tuff of the central facies on the south shore of Bois Island. The Copper Head occurrence consists of disseminated and vein-filling pyrite in a strongly silicified felsic tuff. The zone is more than 30 m thick, is exposed along the shore for more than 100 m, and is faulted against pelitic sediments at its eastern end. The Little Copper Head occurrence occupies a slightly lower stratigraphic position approximately 7.5 km northeast of Copper Head. It comprises minor disseminated pyrite and chalcopyrite in a strongly silicified, reworked felsic tuff horizon approximately 2 m wide. Considerable malachite has washed down the cliff face at this locality making the occurrence look rather more impressive than it actually is. Both of these occurrences appear to be stratabound and are probably synvolcanic in origin.

A number of sulfide occurrences located by NALCO prospectors in the early 1950's west of Facheux Bay (Dunlop, 1954) in rocks of the western facies were re-examined during the present program. Most contain mainly pyrite with very minor galena, sphalerite and chalcopyrite and occur as veinlets and disseminations in a highly deformed, silicified and sericitized felsic tuff horizon (these include the Helicopter showing and trenches 2 - 6 inclusive). The country rocks are dominantly chloritic and graphitic schist although quartz-porphyritic ash flows are present 100 m north of the mineralized horizon. Sporadic mineralization occurs in this horizon along a strike length in excess of 2.5 km, the best of which is found in trench #6 where 45 cm of heavily disseminated galena-pyrite-sphalerite is present. Two other showings in the area, the Cirque and Twin Ponds showings, are in more mafic-looking schist and are probably hosted by slightly different stratigraphic intervals (Figure 3). The Cirque showing is mainly massive pyrrhotite up to 0.5 m thick which contains lesser sphalerite and is exposed over a strike length of roughly 5 m. The Twin Ponds showing comprises a horizon of dominantly massive galena approximately 20 cm wide which has been repeated several times by minor folds resulting in a mineralized width on the ground in excess of 1 m. Both of these showings are structurally conformable to the enclosing country rocks.

In a regional sense, it may be significant that the showings at Facheux Bay, Bois Island and southeastern Bay d'Espoir all appear to occupy a similar stratigraphic position within the Isle Galet Formation. This may be indicative of a relatively widespread period of

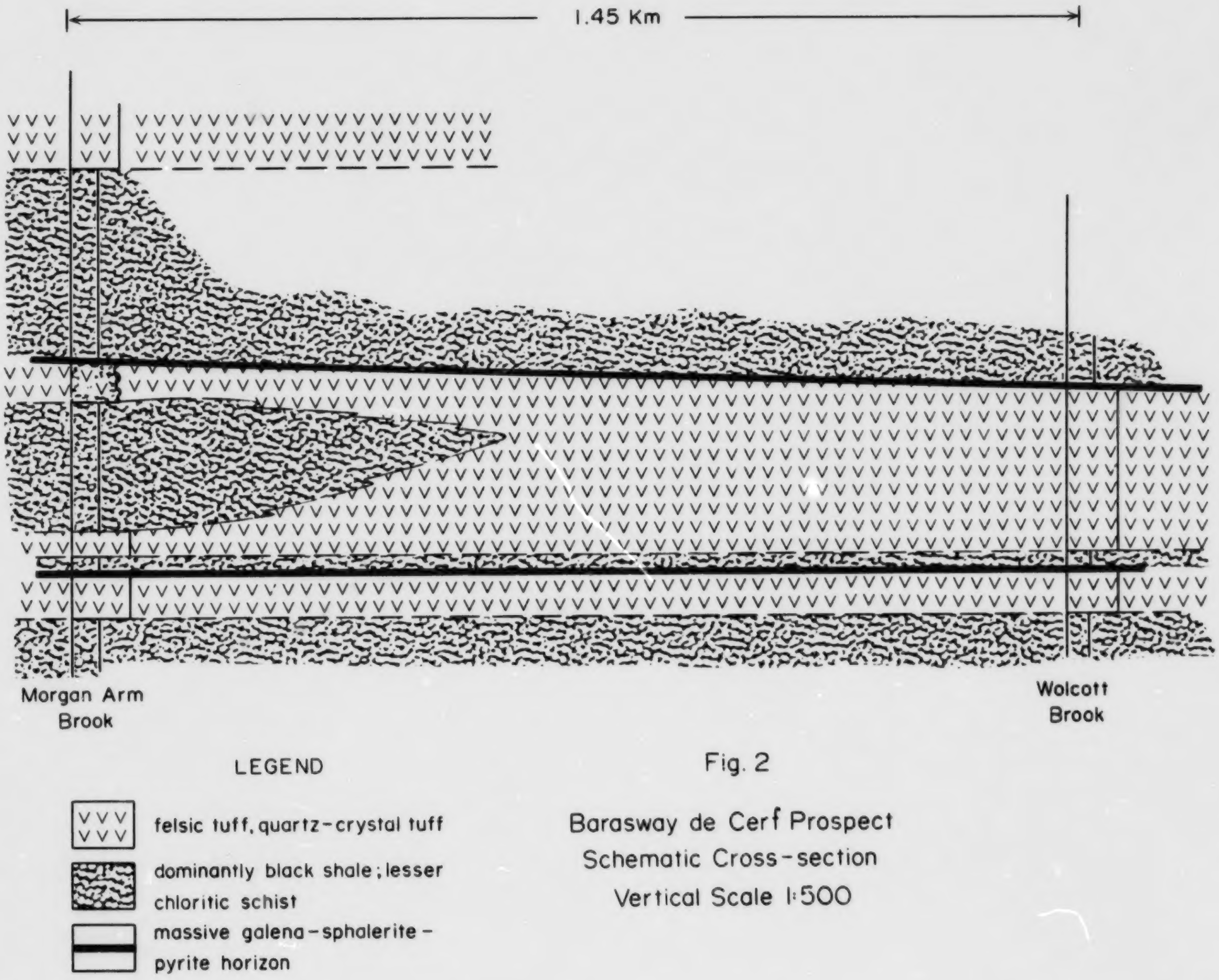
1.45 Km
Morgan Arm Brook
Wolcott Brook
LEGEND
felsic tuff, quartz-crystal tuff
dominantly black shale; lesser chloritic schist
massive galena-sphalerite-pyrite horizon

Fig. 2

Barasway de Cerf Prospect
Schematic Cross-section
Vertical Scale 1:500

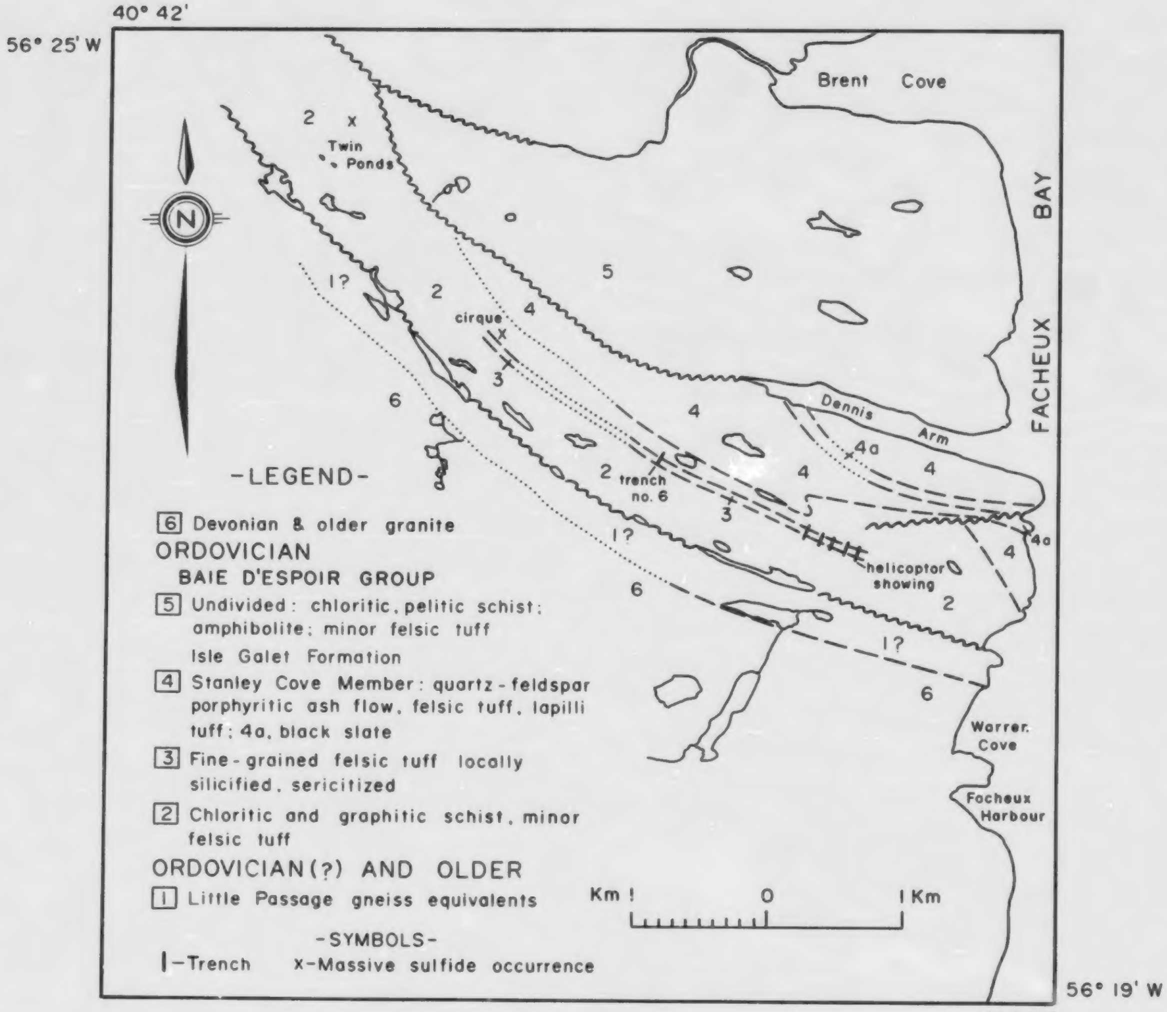
40° 42'
56° 25' W
Brent Cove
BAY
FACHEUX
2
x
Twin Ponds
5
1?
2
cirque
4
3
6
4
Dennis Arm
4a
4
4
2
trench no. 6
3
4a
4
1?
helicopter showing
2
6
1?
6
Warren Cove
Facheux Harbour
-LEGEND-
6 Devonian & older granite
ORDOVICIAN
BAIE D'ESPOIR GROUP
5 Undivided: chloritic, pelitic schist; amphibolite; minor felsic tuff
Isle Galet Formation
4 Stanley Cove Member: quartz-feldspar porphyritic ash flow, felsic tuff, lapilli tuff; 4a, black slate
3 Fine-grained felsic tuff locally silicified, sericitized
2 Chloritic and graphitic schist, minor felsic tuff
ORDOVICIAN(?) AND OLDER
1 Little Passage gneiss equivalents
Km 1
0
1 Km
-SYMBOLS-
I-Trench
x-Massive sulfide occurrence
56° 19' W
40° 38'

FIG. 3

General geology and mineral occurrences of the Isle Galet Formation west of Facheux Bay mineralization which, in the presence of a favourable environment, could have produced a more favourable facies elsewhere in the area.

Two apparently stratabound sulfide occurrences are hosted by basal units of the Riches Island Formation in the Little River Basin, referred to as the Long Jacks Bight and Mine Point showings respectively (Jewell, 1939; Meikle, 1955). The showings at Long Jacks Bight (Long John's Lip of Meikle, 1955) comprise a weakly mineralized horizon within graphitic and quartz-sericitic schists which is 15-20 cm wide, strongly silicified and carries diseminated pyrite, pyrrhotite, arsenopyrite and galena. The zone appears to be conformable and can be traced along a strike length of approximately 100 m. One assay of 12.34g/t (0.36 oz/T) Au and 17.15g/t (0.50 oz/T) Ag was reported by Meikle (1955) but most other assayed samples were essentially barren.

The Mine Point occurrence is hosted by a 6.5 m thick limestone-calc-schist unit within a dominantly graphitic schist sequence. Several beds of pyrite concretions up to 1 cm across accompanied by beds and veinlets of massive pyrrhotite occur in the lower 3 m of this horizon. No economic minerals are reported from this occurrence and its economic potential is probably nil.

EPIGENETIC MINERALIZATION IN BAY D'ESPOIR

Probably the best known epigenetic mineral occurrences in the Bay d'Espoir area are the molybdenite showings north of Lampidoes Passage (Winek, 1954). The mineralization consists of blebs, veins and disseminations of molybdenite with associated pyrite and minor chalcopyrite in pegmatite, aplite and quartz veins which intrude sedimentary rocks of the Baie d'Espoir Group. Beryl is also reported from some of these pegmatites (Winek, 1954) although it was not seen during the present investigation. Numerous minor molybdenite showings were reported by NALCO prospectors along a zone approximately 10 km long parallelling the margin of the North Bay granite; the best of these is developed in and around Northwest Cove, Lampidoes Passage. Prospect locations at South Brook, West Brook, Grandy Pond and Woody Hill Pond reported by Winek (1954) were visited during the present program but no mineralization was noted at any of these localities.

Psammitic schists of the Riches Island Formation are host to a number of dominantly galena-barite occurrences in the vicinity of Roti Bay. Massive blebs and stringers of galena up to 0.5 m long occur in lenticular and crosscutting quartz veins and in veins of massive white crystalline barite. The best of these showings, located in Hardy Cove, comprises a branching barite vein varying from 0.3 to 1 m in width and carrying several blebs of massive galena up to 0.5 m long and 5 cm thick. A second showing on the hill southwest of Hardy Cove has been trenched and comprises a gently dipping quartz lentil which carries lenses of massive galena and lesser pyrite. The total extent of this occurrence on surface is of the order of 100 m^2. Minor amounts of chalcopyrite and sphalerite have been reported from these showings (Jewell, 1939) but were not seen in hand specimen.

A minor galena occurrence was reported by NALCO prospectors on the Bay du Nord River south of Kim Lake, referred to as the Kim Lake #1 showing (Wall, 1956). It comprises sparse galena and pyrite in a quartz vein in pelitic schists which appears to be of very limited extent and of no commercial importance.

Stibnite-bearing mineralization was seen in two localities. At Bowdridge Tickle (Jewell, 1939; referred to as Bower's Tickle by Meikle, 1955) in the Little River Basin, euhedral crystals of arsenopyrite, pyrite and pyrrhotite acompanied by up to 7% stibnite occur in a quartz vein and in adjacent silicified country rock. Although the mineralized zone can be traced intermittently for up to 100 m, the stibnite is restricted to one outcrop at its northern end. Northeast of Kim Lake, a 6-10 cm wide quartz vein hosted by pink prophyritic rhyolite carries sparse blebs and disseminations of stibnite. This showing was referred to as the Kim Lake #2 prospect by previous workers (Wall, 1956) and is of no economic importance.

In addition to the previously mentioned occurrences, several other mineral prospects have been previously reported from the Bay d'Espoir area (*e.g.* Douglas and Hsu, 1976). Many of these localities were visited during the course of the present program but prospects could not be relocated. Most are thought to have been a few specks of sulfides in quartz veins and lentils and are probably of no eonomic significance.

SUMMARY

The Isle Galet Formation of the Baie d'Espoir Group comprises an Ordovician volcano-sedimentary sequence which has been traced along strike in excess of 110 km. It displays a facies variation along strike with a central facies of distal volcaniclastic and epiclastic rocks and tuffaceous sediments being flanked to the west and east by rocks representative of relatively proximal volcanic environments. The western and central facies are host to several minor stratabound sulfide occurrences which are probably synvolcanic in origin and which appear to occupy a mutually similar stratigraphic position. Stratabound mineralization is also found in basal units of the Riches Island Formation. Occurrences of epigenetic sulfides, dominantly molybdenite, galena, arsenopyrite, pyrite and stibnite, are found throughout the eastern Hermitage flexure and are probably related to intrusion of nearby granitoid rocks.

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GEOLOGY AND GEOCHEMISTRY OF THE ACKLEY GRANITE, SOUTHEAST NEWFOUNDLAND

by

W.L. Dickson, P. Elias*, and R.W. Talkington*

INTRODUCTION

During the 1979 field season an extensive reconnaissance geological, geochemical, and spectrometer survey of the Devonian Ackley Granite was carried out. The batholith is located in southeastern Newfoundland with the northern margin approximately 65 km south of the town of Gander (Map 1). The project area is covered by parts of the following 1:50,000 N.T.S. sheets 1M/10, 11, 14, 15, 16, 2D/1, 2, 3, and 7.

The purpose of the project is to outline the major phases within the batholith. Using petrochemical data it is hoped to gain an understanding of the petrogenesis of the batholith and define phases having economic potential.

The general geology of various parts of the batholith has been described by Bradley (1962), Jenness (1963), Anderson and Williams (1970), Williams (1971), and O'Driscoll and Hussey (1978). Recent geochemical studies include a reconnaissance rock geochemical study by Strong et al. (1974), uranium analyses of the rocks collected by Strong et al. (Davenport, 1978), and analyses of lake sediments by Butler and Davenport (1979). Whalen (1976) carried out a detailed geological and geochemical study of the Rencontre Lake molybdenite showings localized near the southern margin of the batholith.

Colman-Sadd (1976) mapped the area (1M/13) adjacent to the southwest margin of the project area and showed that the southeast corner of map area 1M/13 is underlain mainly by deformed granitoid rocks. Therefore, the area between the southwestern edge of the batholith, as shown by Anderson (1965) and the western edge of map area 1M/14 was included in this project in order to define the junction between deformed granitoids and the massive granite of the Ackley Granite (Map 1).

Sampling Methods

The sampling method follows that of Garrett (1979). The area enclosing the Ackley Granite, deformed granitoids, and the country rocks up to 2 km from the previously defined margin were divided into a 4 km^2 grid using the U.T.M. grid system. A randomly chosen sample point was obtained for each square and where outcrop permitted a sample was taken at, or as close as possible to that point. Replication of samples and squares was carried out at the end of the sampling program when the various phases of the batholith had been outlined.

Samples were mainly collected using a float equipped helicopter. 8 lb sledge hammers were used to obtain 2 to 5 kg samples which were then placed in polythene bags. Rock sample size increased with grain and phenocryst size. 757 samples including replicates were obtained from the approximately 960 squares which covered the project area (Map 2). 640 granite samples will be analysed for SiO_2, Al_2O_3, Fe_2O_3, FeO, MgO, CaO, Na_2O, K_2O, TiO_2, MnO, P_2O_5, Loss on Ignition, Ba, Rb, Sr, Zr, F, Cu, Zn, Mo, Pb, Li, V, U, and Be.

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GEOLOGY

The Ackley Granite is a large irregular body of massive coarse grained biotite granite which is intrusive into late Precambrian volcanic and sedimentary rocks of the Avalon Zone and pre-Middle Ordovician metasediments and Devonian and older granitoids of the Gander Zone (Williams, 1978). The Dover-Hermitage Bay Fault forms the boundary between the Gander and Avalon Zones (Blackwood & O'Driscoll, 1976).

Unit 1 (Late Precambrian metavolcanic and sedimentary rocks - Avalon Zone)

Unit 1 includes all the country rocks to the southeast of the Dover - Hermitage Bay fault. This unit is composed of parts of the Love Cove, Long Harbour, and Musgravetown Groups (Williams, 1971; O'Driscoll and Hussey, 1978). The Love Cove and Long Harbour Groups are composed dominantly of acid pyroclastic and related epiclastic rocks with minor basic flows and clastic sediments. The Musgravetown Group is composed mainly of well sorted, medium grained, crossbedded sandstone and siltstone with minor basic volcanics. These rocks were deformed and metamorphosed to lower greenschist facies probably during the Acadian Orogeny. Contact metamorphism of Unit 1 has produced cordierite porphyroblasts in the Musgravetown Group and biotite porphyroblasts in the Love Cove Group metasediments. The acid volcanic rocks show recrystallization textures and the basic volcanics have been metamorphosed to produce an amphibolite. There is evidence of partial melting and gneissification of the rocks near the contact on Route 102.

Intrusive contacts between the Ackley Granite and the Precambrian rocks were observed at (i) Long Harbour, (ii) Route 102 about 20 km northeast of Terrenceville, (iii) Dunns Mountain, (iv) a locality 15 km northeast of The Tolt, (v) Belle Harbour, (vi) Rencontre Lake, (vii) Wylie Hill molybdenite showing, (viii) Motu molybdenite showing and (ix) Ackley City molybdenite showing. Contacts are generally sharp and crosscut the main fabrics in the country rocks. There is only minor screen formation and assimilation of the country rocks.

A series of roof pendants which trend south from The Tolt are probably part of the Precambrian Andersons Cove Formation of the Long Harbour Group (Williams, 1971) and not Cambrian and Ordovician as suggested by Bradley (1962). (See O'Brien and Nunn, this volume).

Unit 2 (Middle Ordovician and older metasedimentary rocks - Gander Zone)

Unit 2 is composed mainly of semi-pelitic to psammitic, low to medium grade polyphase deformed schists and minor metavolcanic rocks. This unit is located to the northwest of the Dover - Hermitage Bay Fault and forms part of the Middle Ordovician and older Gander and Baie D'Espoir Groups. These rocks form the eastern part of the Gander Zone (Williams, 1978). Metamorphism of Unit 2 decreases from amphibolite facies schists and migmatites in the southeast to lower greenschist facies slates in the northwest over a distance of 15 km or less.

No intrusive contacts between the Ackley Granite and Unit 2 were observed. The effects of contact metamorphism, however, are clear in the Kepenkeck Lake area where up to 1 cm long porphyroblasts of cordierite have developed in the metasediments. In the deformed granite terrain (Units 4, 5, and 6) the metasediments are cut by numerous granite sheets so that subdividing this region into areas of metasediment and granite is difficult at this scale of mapping. One possible roof pendant of metasediment within the Ackley Granite was observed 5 km south-southwest of Jubilee Lake.

MAP 1 - GEOLOGY OF THE ACKLEY GRANITE

LEGEND

Devonian or younger
Ackley Granite - Units 7-9

9. Medium grained massive uniform biotite-muscovite granite.

8. Massive uniform biotite granite - generally coarse grained.

    8a Big Blue Hill Pond Facies

        $8a^1$ Medium grained variety

    8b Long Harbour Facies

        $8b^1$ Medium grained variety

        $8b^{11}$ Fine grained porphyritic variety

7. Coarse grained massive K-spar porphyritic biotite granite.

    7a Tolt Facies

    7b Jubilee Lake Facies

Devonian or older

6. Foliated medium to coarse grained muscovite granite.

5. Foliated medium grained biotite granite.

    5a Foliated medium grained biotite-muscovite granite.

4. Foliated coarse grained K-spar porphyroclastic biotite granite.

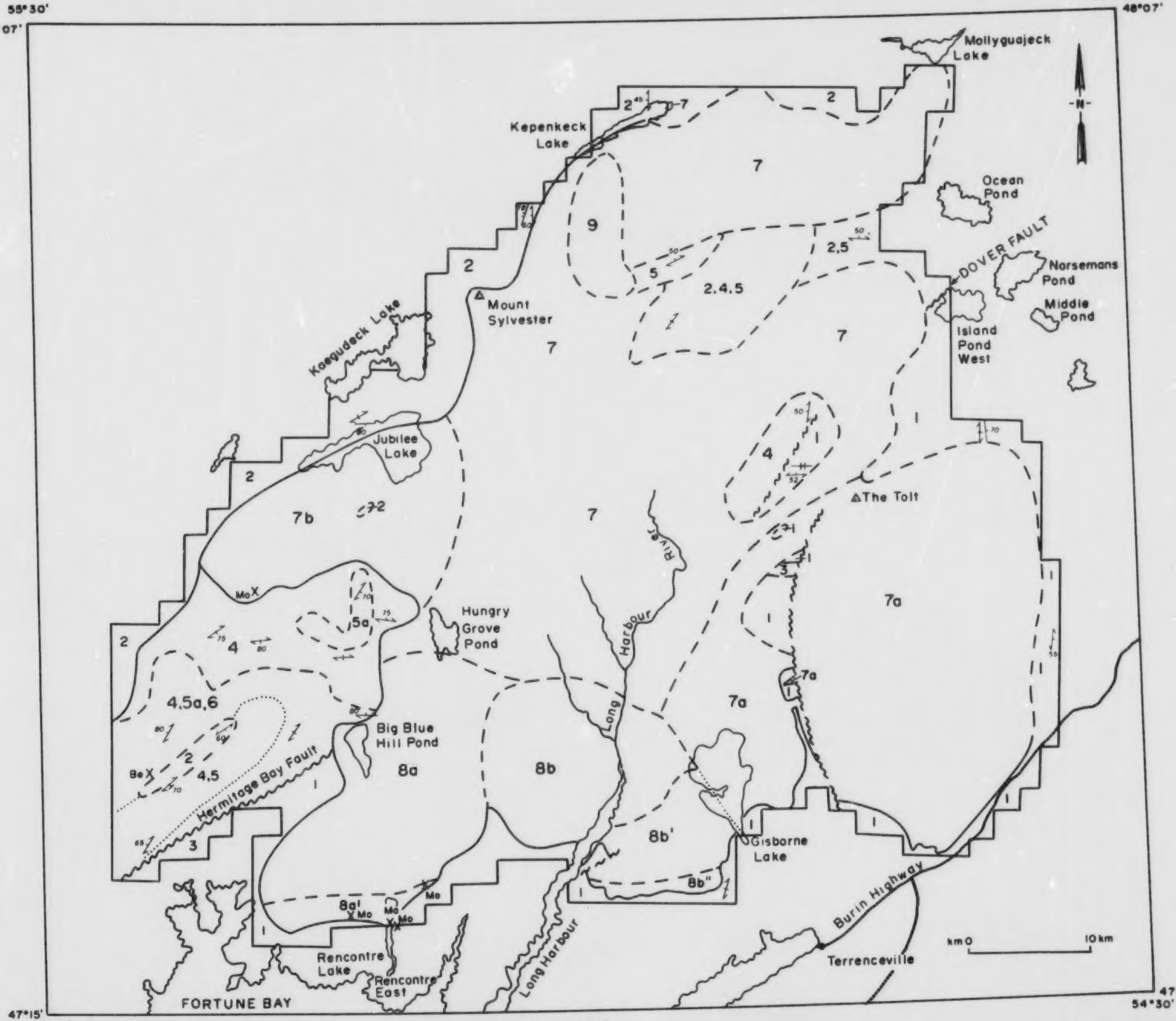
3. Slightly foliated coarse grained hornblende-biotite granodiorite and monzodiorite.

Ordovician and older

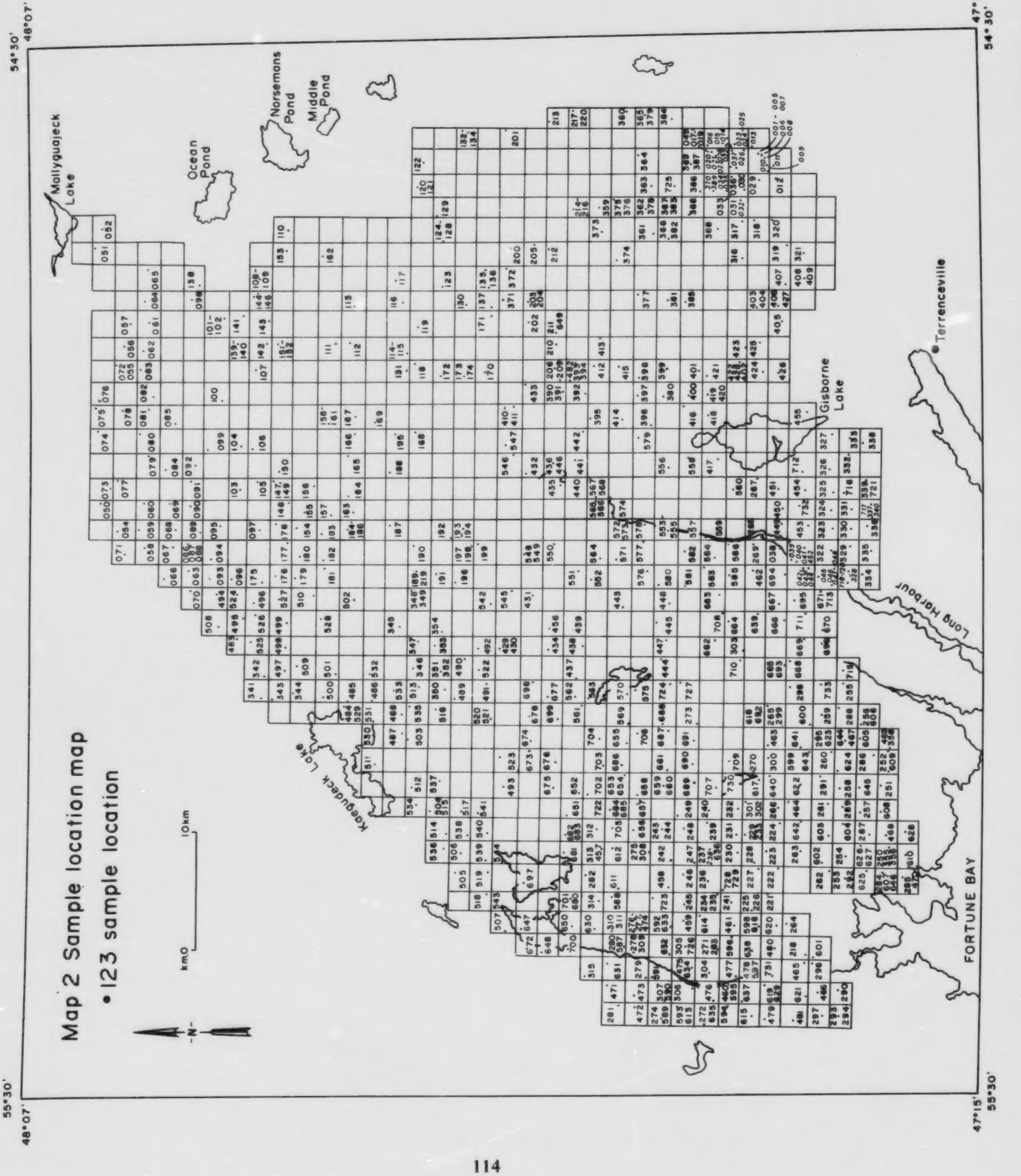
2. Gander and Bay D'Espoir Groups - metasediments.

Precambrian

1. Love Cove, Musgravetown and Long Harbour Groups - metavolcanics and metasediments.


55°30'
48°07'
54°30'
48°07'
Mollyguajeck Lake
-N-
Kepenkeck Lake
Ocean Pond
DOVER FAULT
Norsemans Pond
Middle Pond
Island Pond West
Mount Sylvester
Kaegudeck Lake
Jubilee Lake
The Tolt
River
Harbour
Long
Hungry Grove Pond
Big Blue Hill Pond
Hermitage Bay Fault
Gisborne Lake
Burin Highway
Terrenceville
km 0
10 km
Rencontre Lake
Rencontre East
Long Harbour
FORTUNE BAY
47°15'
55°30'
47°15'
54°30'
1
2
2,5
2,4,5
3
4
4,5
4,5a,6
5
5a
7
7a
7b
8a
8al
8b
8b'
8b"
9
Mo
Be
50
52
55
60
65
70
75
80

MAP 1



Map 2 Sample location map

• 123 sample location

54°30'
48°07'
47°15'
54°30'
55°30'
48°07'
47°15'
55°30'
Mallyguajeck Lake
Ocean Pond
Norsemans Pond
Middle Pond
Gisborne Lake
Terrenceville
Long Harbour
FORTUNE BAY
Kaegudeck Lake
km 0
10 km
N

Unit 3 (Pre-Ackley Granite Intrusions - Avalon Zone)

This unit occurs in widely separated outcrops and includes part of the Simmons Brook Batholith. The unit occurs to the southeast of the Dover - Hermitage Bay Fault. The Simmons Brook Batholith has been described by Williams (1971). In summary, it consists of "medium to coarse grained, altered gray to pink granite and granodiorite, fine to medium grained diorite and quartz diorite". Two occurrences of weakly deformed and metamorphosed hornblende-biotite granodiorite and monzodiorite occur in the northernmost roof pendant southwest of The Tolt (Pin Hill) and also 10 km due west of The Tolt. The rocks at these localities fit the descriptions of the Simmons Brook Batholith and therefore may be related. Clear intrusive contacts were observed at Pin Hill where the monzodiorite has intruded acid volcanic rocks. Contacts were not found at the pendant west of The Tolt.

Units 4, 5, 6 (Pre-Ackley Granite deformed granitoids - Gander Zone)

These units occur in the southwestern part of the survey area with two other major remnants located 30 km to the northeast of Big Blue Hill Pond. Units 4, 5, and 6 occur to the north of the Dover - Hermitage Bay Fault.

Unit 4 consists of variably deformed medium to coarse grained, K-spar porphyroclastic, biotite granite. The K-spar porphyroclasts form augen which vary in length from 5 mm to 3 cm. Flattened and granulated quartz and feldspar along with micaceous layers define the main fabric.

Unit 5 consists of strongly foliated, medium grained biotite granite which may grade into biotite-muscovite granite (Unit 5a). Unit 5 is equivalent to Colman-Sadd's (1976) "garnetiferous leucocratic granite and related rocks". Colman-Sadd (1976) has suggested that the garnetiferous leucocratic granite is Middle Ordovician or younger as the lithologically similar North Bay Granite is intrusive into the fossiliferous Riches Island formation of probable Middle Ordovician age.

Unit 6 is a foliated, medium grained, uniform, muscovite granite. This rock type commonly occurs as dikes, within the deformed terrain but also as large isolated outcrops. Garnet was found in a few isolated outcrops and is commonly associated with 1 to 4 cm irregular poikilitic tourmaline. Garnet was never found in association with biotite in the granitic rocks.

Units 4, 5 and 6 are cut by numerous granitic and graphic textured pegmatites some of which are deformed. The pegmatites are generally barren but at one locality beryl was discovered.

The separation of rocks into Units 5 and 6 is tenuous because of possible gradational changes within biotite-muscovite granites from a biotite-free marginal zone to a muscovite-free core (see Colman-Sadd, 1976; Currie and Pajari, 1977). Also complex intrusive relationships between Units 2, 4, 5 and 6 make it difficult to define the main rock type in an area.

Unit 4 is considered to be older than Units 5 and 6 as dikes of biotite granite (Unit 5), biotite-muscovite granite (Unit 5a) and muscovite granite (Unit 6) commonly cut Unit 4. These units (4, 5, 6) are deformed with a well developed L-S fabric which is generally steeply dipping. The fabric generally trends northeast but in the area north of Big Blue Hill Pond the fabric trends towards the east. In a few places there is a poorly developed fracture cleavage which cuts the main fabric. The overall fabric in the granites is parallel to that of the metasediment screens and suggests that all were deformed together probably during the Acadian Orogeny.

Units 7, 8, 9 (Ackley Granite)

These units form what is here defined as the Ackley Granite. The rock is generally fresh and massive and clearly crosscuts the regional fabric. The Dover-Hermitage Bay Fault is truncated by the batholith. A possible roof pendant 5 km west of The Tolt may contain a remnant of the originally continuous Dover-Hermitage Bay Fault. Dallmeyer has dated the eastern part of the Ackley Granite using $^{40}Ar/^{39}Ar$ incremental release age spectra on primary hornblende and obtained an age of 356±10 Ma (Geochronology report, this volume).

Unit 7 is composed of generally coarse grained massive porphyritic biotite granite. Phenocrysts consist of 2 to 5 cm long K-spar crystals which commonly show albite mantles. The granite is generally hypidiomorphic granular and locally grades into lenses and small sheets of pegmatitic and aplitic granite. The northern part of the batholith, which is undivided because of poor outcrop, contains small areas of uniform, coarse grained, biotite granite.

Unit 7a, The Tolt facies, is characterised by generally coarse to very coarse grain size, large (>2 cm) phenocrysts and an abundance of miarolitic, aplitic and porphyritic alaskite veins, pods, and dikes.

Unit 7b, the Jubilee Lake facies, is also coarse grained, porphyritic biotite granite but pods of aplite and alaskite are rare. Low gamma-ray spectrometer counts are characteristic of this phase. A prominent aeromagnetic anomaly which trends southwards for 15 km starting from just east of Jubilee Lake to Hungry Grove Pond may represent the contact between Unit 7 and Unit 7b.

Unit 8 consists of generally coarse grained uniform biotite granite. Towards the southern margin Unit 8 becomes finer grained, extremely friable, and may contain rare 1 cm K-spar phenocrysts. The unit is subdivided into facies 8a and 8b mainly on the basis of gamma-ray counts with Unit 8b generally twice as high as Unit 8a. Also, lake sediment geochemistry (Butler and Davenport, 1979) shows the area underlain by Unit 8a to be higher in Zn, Pb, and Mo than that of 8b. A prominent northerly trending aeromagnetic lineament coincides with this subdivision.

Unit $8a^1$ is a finer grained variety of 8a. Towards the contact with the country rocks, $8a^1$ becomes alaskitic and locally fine grained. These rocks are the host for the main molybdenite showings in the batholith. Units $8b^1$ and $8b^{11}$ are sucessively finer grained varieties of Unit 8b. Locally pods of $8b^1$ and $8b^{11}$ are found in 8b.

Near the margin, the granite is highly miarolitic and locally tuffisite has developed. This suggests that the granite crystallized at a high level in the crust probably less than 3-4 km (see Hughes, 1971). The decrease in grain size may be related to rapid nucleation caused by rapid loss of volatiles and thus a decrease in pressure.

Unit 9 is located in the northern part of the batholith and is possibly the youngest unit of the Ackley Granite. The unit is unique in that it is the only massive megascopically muscovite-bearing granite in the survey area. Unit 9 is generally medium to coarse grained, massive, uniform to locally porphyritic, biotite-muscovite granite. The muscovite content varies from less than 1% to about 3%. The unit probably underlies a much greater area than is shown by surface outcrop as a corresponding pronounced aeromagnetic low covers an area at least twice that delimited by surface outcrop.

Diabase Dikes

Diabase dikes are common in the Precambrian terrain (Unit 1) but are rare in both the deformed granitoids and the Ackley Granite. Dikes are more abundant in the deformed granitoids than the Ackley Granite. Within the Ackley Granite the diabase dikes are generally massive and slightly metamorphosed. Jayasinghe (1978, 1979) has suggested that diabase dikes which cut similar granites in the Wesleyville area, 125 km to the north are probably late Devonian or early Carboniferous in age.

SPECTROMETER SURVEY

At most sample localities either a scintillometer reading (Scintrex BGS-1) or spectrometer (Scintrex GIS-4) reading was taken. "Total Counts", "U+Th", and "Th" were the channels recorded using the spectrometer. Only "Total Counts" were recorded with the scintillometer.

The average results for the project area are:

1. Total Counts	170 counts per second (cps)
2. U+Th	1.5-2 counts per second
3. Th	1

The deformed granitoids and the Jubilee Lake facies (Unit 7b) yield average readings of approximately 130 cps. Unit 8 gave the highest readings of 250 to 400 cps. The more differentiated granitic rocks of the Ackley Granite (*e.g.* aplites, granitic pegmatites) give above average readings. The pegmatites in the deformed granitoid terrain yield below average readings.

High "U+Th" counts were shown to be directly correlatable with high "Total Counts". The Long Harbour facies and subfacies showed the highest "U+Th" readings, with up to 15 cps in subfacies $8b''$. Davenport (1978) reports uranium contents of granite samples from the Ackley Granite are highest (ave. 12 ppm) in the Long Harbour area. Whalen (1976) reported microscopic uraninite from the Rencontre Lake molybdenite showings (Unit $8a'$). However, spectrometer readings taken at these showings are similar to the batholith "average" and about half that obtained from Unit 8b (Long Harbour facies).

MINERALIZATION

The Ackley Granite is well known for the molybdenite mineralization in the Rencontre Lake region. There are four significant molybdenite showings of which the Wylie Hill, Ackley City and Motu are of the porphyry type and the Crow Cliff-Dunphy Brook showing is a vein-type occurrence. These four showings occur very close to the contact between Unit 8a and Precambrian volcanic rocks. No molybdenite is found within the country rocks near the showings (see Whalen, 1976 for full description). Contact zones between the batholith and country rocks in other areas were examined for mineralization. Mineralization was found in small quartz veins with 2 to 5 mm crystals of molybdenite in the Jubilee Lake area. Mineralization is apparently restricted to the quartz veins in this area. The occurrence is close to the contact between the deformed granitoids and the Jubilee Lake facies (Unit 7b). Molybdenite mineralization was found also in small quartz veins about 12 km south-southeast of The Tolt. The veins and the molybdenite are both of limited extent and occur in The Tolt facies (Unit 7a). This area contains anomalous Mo in lake sediment samples (Butler and Davenport, 1979).

Beryl was found in pegmatite veins in deformed muscovite-biotite granite west of the Bay du Nord River. Faceted crystals up to 1 cm were obtained. The extent of the mineralized veins is not known.

SUMMARY

1. The Ackley Granite is a posttectonic high level Devonian intrusion.
2. The batholith cuts deformed granitoids south of Jubilee Lake and is intrusive into the metasediments and metavolcanics of the Gander and

Avalon Zones.

3. The Dover-Hermitage Bay Fault is truncated by the batholith.
4. The batholith can be divided into 3 major units based on mineralogy and texture.
5. Gamma radiation is highest in the Long Harbour area.
6. Minor molybdenite mineralization was found in quartz veins south of Jubilee lake.
7. Beryl was found in pegmatites in deformed leucogranite west of the Bay du Nord River.

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TERRENCEVILLE (1M/10) AND GISBORNE LAKE (1M/15) MAP AREAS, NEWFOUNDLAND

by

S.J. O'Brien and G.A.G. Nunn

INTRODUCTION

Geological mapping of the Terrenceville (1M/10) and Gisborne Lake (1M/15) map areas was carried out during the 1979 field season. The area has been mapped previously on a scale of 1:63,360 by Bradley (1962). Revision of this earlier work was deemed necessary in the light of results from recent mapping elsewhere in the Burin-Merasheen project area; *ie*. O'Driscoll, 1977; O'Brien, 1978; Strong *et. al*. 1978; O'Brien and Taylor, 1979; O'Driscoll and Muggridge, 1979 and in the adjacent Belleoram (1M/11) map area (Williams, 1971).

The study area forms a part of the much larger Avalon Zone of the Newfoundland Appalachians (Williams *et. al*, 1974) that consists of Late Precambrian volcanic, sedimentary and plutonic rocks locally overlain by Lower to Mid-Paleozoic sedimentary rocks.

The geological evolution of the area can be tentatively outlined by way of several rudimentary tectonic stages. The earliest is characterized by dominantly subaerial, felsic to mafic volcanism and associated granitoid plutonism with minor contemporaneous sedimentation. Cessation of volcanism coincided with the onset of shallow water, non-calcareous, terrigenous clastic sedimentation. Renewed, localized, silicic volcanism gave way to terrestrial sedimentation in the uppermost Precambrian.

The region was subjected to deformation and dynamothermal metamorphism during the Acadian orogeny. Syn- to postorogenic molasse was deposited in restricted basins during the Devonian. Widespread granitoid emplacement constitutes one of the later tectonic stages recognized in the region.

Formation names in this report are not meant to be used formally although some of them have been used by Bradley (1962).

STRATIGRAPHY

Unit 1

The oldest exposed rocks in the Terrenceville-Gisborne Lake area are a succession of dominantly subaerial, silicic and subordinate mafic volcanics with minor clastic sediments. They are exposed in three, broad northeast-trending belts which underlie approximately 60% of the Terrenceville map area.

Bradley (1962) concluded that the volcanic rocks in these three outcrop belts constituted separate stratigraphic units including from east to west, the Precambrian Deer Park Pond (Unit 1a) and underlying Southern Hills (Unit 1b) Formations and the Ordovician Belle Bay and Grand Le Pierre Formations (Unit 1c). Our mapping, however, suggests that these units represent stratigraphically equivalent facies variants within a single major Precambrian volcanic field.

Unit 1a (Deer Park Pond Facies)

The easternmost volcanic belt consists of mafic and felsic massive flows and related volcaniclastic deposits of mafic to felsic composition. The dominant silicic volcanic lithotypes are ash flow tuffs and spatially associated tuffaceous deposits of uncertain origin. Strongly foliated and unstratified lithic and crystal-lithic air-fall(?) tuffaceous rocks are volumetrically only slightly less significant. Massive and flow banded rhyolite flows are a minor constituent of this belt.

Mafic flows and hypabyssal rocks are less extensive and constitute approximately 5-10% of the outcrop area east of the Cape Roger Mountain Batholith. Fine to medium grained mafic and intermediate crystal tuffs are most common in the western part of the belt, where they have been thermally metamorphosed by the Cape Roger Mountain Batholith.

Epiclastic sediments are rare in the lowest stratigraphic levels of unit 1a and are limited to individual beds or thin intraformational units. Several major clastic units occur in the upper levels of unit 1a. These are discussed below (see section 1d).

The base of unit 1a is not exposed in the map area. A small synclinal keel of unit 2 directly overlies the volcanics near the western margin of the belt. As these sediments also overlie unit 1b, it is suggested that unit 1a is stratigraphically equivalent to the adjacent central belt and that the facies boundary between these units is steep. The possibility exists, however, that at least the lower parts of unit 1a represent the lowest level of unit 1 and stratigraphically underlie the adjacent Southern Hills Facies.

Unit 1b (Southern Hills Facies)

The central volcanic belt is underlain by a succession of ash flow tuffs and rhyolite flows which are locally intercalated with very minor epiclastic sedimentary lenses.

Most of unit 1b consists of densely welded and moderately to strongly flattened ash-flow deposits. These include red, gray and black, very fine grained vitrophyres, ash tuffs, lithic and pumice-rich lapillistones and vitric or crystal-vitric tuffs. Coarse grained lapillistones and gray felsic tuff-breccias are of minor volumetric importance and epiclastic volcanic breccias are absent.

Massive, nonpyroclastic felsic flows may constitute up to 10% of the outcrop area of this belt and are spatially and genetically related to the ash-flow volcanism. They include very fine grained glassy or slightly porphyritic rhyolites, pink and orange saccharoidal textured rhyolites or felsites and flow-banded rhyolites.

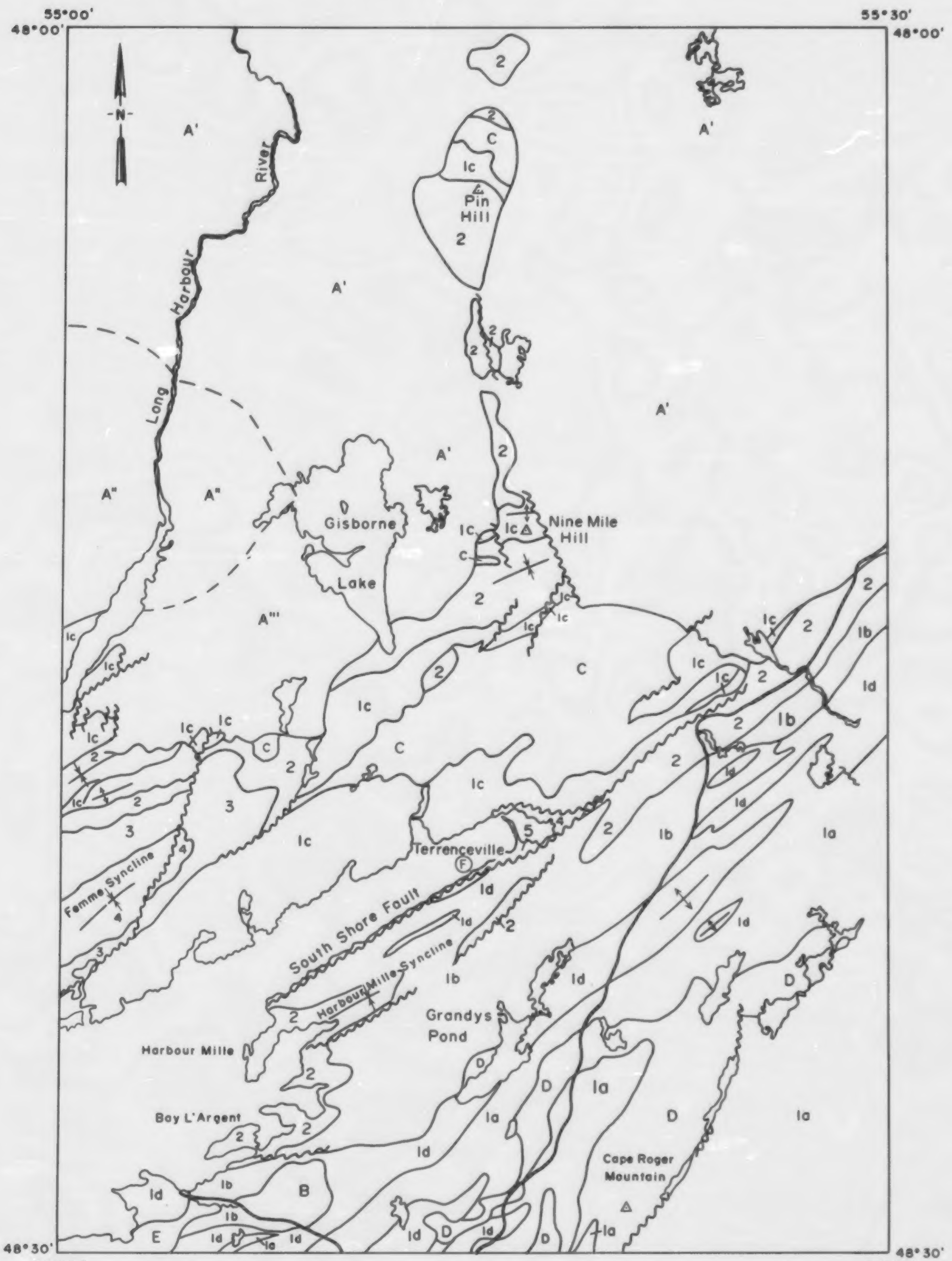
Cleaved, vitric-crystal and lithic tuffs of probable air-fall origin are interleaved with welded ash-flow deposits mostly in the eastern part of the belt.

Unit 1b is conformably overlain by clastic sediments of the Anderson's Cove Formation (unit 2) in the Harbour Mille Syncline and east of the South Shore Fault System in the east-central part of the map area.

Unit 1c (English Harbour East Facies)

The rocks of the western volcanic belt, which includes the Belle Bay and Grand Le Pierre Formations of Bradley (1962), are products of dominantly felsic ash-flow volcanism with associated coarse grained epiclastic deposition and relatively minor mafic volcanism.

Felsic volcanic lithotypes include moderately to strongly welded and flattened pumice-rich ash-flows, unwelded lithic lapillistones and associated air-fall tuffs, rhyolitic to basic tuff-breccias and agglomerates. Massive flows of rhyolitic and rhyodacitic(?) composition are volumetrically less important.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Long Harbour River
Pin Hill
Gisborne Lake
Nine Mile Hill
Terrenceville
South Shore Fault
Femme Syncline
Harbour Mille Syncline
Harbour Mille
Grandys Pond
Bay L'Argent
Cape Roger Mountain
Ia
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LEGEND

VOLCANIC AND SEDIMENTARY ROCKS

DEVONIAN

5 Predominantly red sandstones and fine to medium grained conglomerate with subordinate siltstones (Terrenceville Formation)

PRECAMBRIAN

4 Predominantly maroon, fine to coarse grained conglomerates with minor sandstones and subordinate rhyolite volcanics. (Rencontre Formation)

3 Predominantly ash flow tuffs and rhyolites with minor basic rocks. (Mooring Cove Formation)

2 Fine to very coarse grained clastic sediments and thermally metamorphosed equivalents with subordinate basic sills and flows. (Anderson's Cove Formation)

1 Subaerial felsic and mafic volcanics with minor sediments, flows and hypabyssal intrusions.

1a, Predominantly mafic and felsic tuffs with subordinate basic rocks and minor ash flows, rhyolites (Deer Park Pond Facies) and clastic sediments.

1b, Predominantly ash flow tuffs, rhyolites and felsic tuffs with subordinate clastic sediments and basic rocks (Southern Hills Facies).

1c, Predominantly ash flow tuffs and volcanic breccias with minor rhyolitic and basaltic flows and red and green clastic sediments (English Harbour East Facies).

1d, Predominantly medium to coarse grained sandstones and fine grained conglomerates with finer grained clastics.

NOTE: Formation names in this report are not meant to be used formally although some of them have been used by Bradley (1962).

IGNEOUS ROCKS

DEVONIAN

A Ackley City Batholith

- A^{1} Coarse grained, massive, K-spar porphyritic biotite granite

- A^{11} Coarse grained, massive, uniform textured biotite granite.

- A^{111} Fine and medium grained, massive, uniform textured biotite granite.

B Berry Hill Stock: Medium grained adamellite with minor granite and aplite.

C Cross Hills Batholith: Medium grained hornblende granodiorite and fine grained alaskite, with subordinate diorite, recrystallized fine grained granitoid and foliated or unfoliated diabase, volcanic, sedimentary and minor gabbro xenoliths.

PRECAMBRIAN

D Cape Roger Mountain Batholith: Fine to medium grained foliated hornblende biotite granodiorite with subordinate gabbro and minor aplite and diabase dikes.

E Deepwater Point Pluton: Medium grained foliated hornblende biotite granodiorite with minor aplite.

Mafic volcanics include massive, amygdaloidal and blocky, finely vesicular aa basalt flows. Very coarse grained laharic deposits are unique to the western volcanic belt and constitute a significant proportion of it. Fine to coarse grained epiclastic sedimentary rocks are spatially related to the lahars.

Volcanism in the western belt can be tentatively subdivided into three stages. An initial period of felsic pyroclastic volcanism resulted in the deposition of partially welded,medium grained, feldspathic and quartzofeldspathic crystal and crystal-lithic tuffs of Bradley's (1962) Grand Le Pierre Formation. The ash-flow volcanism is superseded by deposition of coarse grained laharic breccias and related epiclastic rocks of the lower parts of Bradley's (1962) Belle Bay Formation. Bradley (1962) suggested that the contact of these formations was an angular unconformity. However, our mapping indicates that the contact is conformable and represents the transition from pyroclastic to epiclastic deposition. The epiclastic deposits consist of fine to very coarse grained crudely stratified or chaotic laharic breccias and interstratified fine to coarse grained, red and green, siliceous clastic sediments. Silicic pyroclastic activity is continuous throughout this stage, but the deposits are restricted in volume. A resurgence of volcanicity marks the latest stage and resulted in the deposition of voluminous welded ash-flow tuffs and less extensive massive rhyolitic and basaltic flows.

Unit 1c conformably underlies clastic rocks of unit 2 in the Long Harbour Syncline and in anticlinal cores near Gisborne Lake and Nine Mile Hill.

Rocks underlying the Rencontre Formation (unit 4) in the Femme Syncline, which Bradley (1962) included in the Belle Bay Formation, stratigraphically overlie adjacent clastic sediments of unit 2. This relationship indicates that these volcanics are correlative with the Mooring Cove Formation of Williams (1971) and should not be included in the Belle Bay Formation.

Unit 1d (Clastic sediments)

Sedimentary rocks occur as intercalations throughout the eastern, central and western volcanic belts. In the stratigraphically lower levels of unit 1a they are limited to a few individual beds or thin units of gray to purple granule sandstones and conglomerates. Within unit 1b, periodic clastic units form from 5 to 10% of the succession in bands usually tens of metres thick but locally attaining thicknesses up to 350 m. A similar distribution of clastics occurs in unit 1c where the thickest units are most common in the lower stratigraphic levels. The major lithotypes are gray-green litharenites and fine grained conglomerates and represent intraformational epiclastic deposits.

Several major clastic intercalations occur towards the top of unit 1a. They occur in an anticlinal belt northeast and southwest of Grandy's Pond, at higher levels in a synclinal keel southeast of this zone and in several minor synclines between the two larger structures. The largest of these forms the Grandy's Pond Anticline and is a succession of dirty and immature arenites and interbedded granule to pebble sandstones and conglomerates. Interbedding of tuffs and arenites is present in the uppermost stratigraphic level of the sediments. Structural studies suggest that this unit should outcrop again to the southeast, above the lower levels of unit 1a, or be laterally replaced by the volcanics. Patches of clastic sediment in the area of the Cape Roger Mountain Batholith may represent this repetition.

The sedimentary sequences of unit 1d are characterized by generally very immature, poorly sorted sandstones with subordinate, similarly textured, polymictic conglomerates. The former are predominantly medium to coarse grained, massive, ungraded feldspathic litharenites. Other diagnostic features include the presence of magnetite laminae and moderate to large scale crossbedding. The conglomerates, though polymictic, contain almost exclusively acid volcanic clasts.

The only significant facies variations occur in sediments in the Grandy's Pond Anticline. In the south, near St. Bernards, granule to pebble sandstones and conglomerates are predominant and are locally interbedded with thin pyroclastic units. Northeast of Grandy's Pond the main facies of the belt is a succession of cleaner, better sorted arenites with relatively few conglomerate layers.

The clastic deposits of unit 1d are characteristic of shallow water, moderate to high energy shelf sedimentation.

Unit 2 (Anderson's Cove Formation)

Unit 2 occurs in two main belts northwest of the unit 1 volcanics which they directly overlie. The southern belt extends from Bay L'Argent northeastwards to the Paradise River. The northern belt extends from the entrance of Long Harbour, on the adjacent Belleoram (1M/11) sheet, northeast to Nine Mile Hill and thence northwards through a line of roof pendants in the Ackley Granite to the northern edge of the map area.

This formation is in both stratigraphic conformity and tectonic contact with the underlying volcanics with two possible exceptions east of Gisborne Lake (see below). A coarse clastic basal unit, varying from tens to hundreds of metres in thickness, generally occurs at this contact. In some places, an otherwise conformable relationship is interrupted by basic sills or flows. The boundary is always sharp and generally represents a cessation of acidic volcanic activity except for rare felsic tuffs in unit 2. Contemporaneous basic volcanicity is discussed below. The formation varies considerably in sedimentary evolution throughout its outcrop. Nearly all the sediments of unit 2 are gray or dark green in color.

Southern Belt

In the Bay L'Argent area basic flows overlying unit 1b volcanics are followed by a thin basal conglomerate and then a well bedded succession of conglomerates, sandstones and laminated siltstones. The latter lithotype is dominant with thin interbedded muddy sandstones, fine grained conglomerates and a few aquagene vitric and crystal-vitric tuffs. It contains 2-20 m cycles in which the dirty, poorly sorted, coarser clastics are dominant. 2 km southwest of Bay L'Argent the sediments are sharply interrupted by a gradually fining upwards 300-400 m thick boulder conglomerate unit and 1 km northeast of Harbour Mille sandy cycles pass up into an homogeneous sandstone wedge representing a local coarsening up of the sequence. At Harbour Mille, a general coarsening and reddening characterizes the top of the exposed succession. Light colored sandstones with minor red mudstones are overlain by coarser, partly pebbly, sandstones with red siltstones.

South of Terrenceville a thin slice of the Anderson's Cove Formation consists of gray, mafic, vitric-lithic tuffs overlain by granule to pebble conglomerates which conformably overlie unit 1b. Other outcrops of more typical laminated facies occur within the area of unit 1b and as a synclinal keel in unit 1a.

In the area around Paradise River and extending southwest towards Terrenceville, the Anderson's Cove Formation typically consists of medium to coarse grained, feldspathic litharenites with granule and pebble clast-bearing beds. Here, light gray, cleaner and better sorted sandstones predominate over the gray and green dirty types which are associated with minor laminated siltstones (cf. Bay L'Argent area). The uppermost light colored sandstones are interbedded with minor red siltstones (*cf.* Harbour Mille section). Mafic, vitric-lithic lapilli tuffs are also present in this area.

Northern Belt

The northern belt, excluding that part north of Nine Mile Hill, is characterized by very coarse clastics. Thick wedges of conglomerate occur at its western and eastern ends. The conglomerates thin to the north and fine both northwards and up sequence. Their thicknesses vary from approximately 850 m to 0 m in the west and from about 850 m to 300-400 m in the east. Along the northern edges of this belt both of these sequences pass up into a laminated siltstone facies with thin sandstone interbeds. In the west, however, the formation is conformably overlain on its southern margin by another acidic volcanic sequence (unit 3) and the conglomeratic beds comprise the complete succession. Between the conglomerate wedges dirty sandstones predominate while conglomerates are subordinate and fine grained clastics minor. The sandstones contain a few clean, light gray sublitharenites; a lithotype which is otherwise only found north of Nine Mile Hill.

1.2 km north of Nine Mile Hill the boundary between Units 1c and 2 is discordant to the bedding in both and the latter may be unconformable on the volcanics. In the roof pendant zone, clean, light gray sublitharenites become interbedded upwards with subordinate gray and purple siltstones before giving way to laminated siltstones with thin sandstone beds. West of Mary Ann Pond, the arenite units are thicker and coarser, with local granule sandstone or conglomerate beds, and exclude the finer clastics. At Pin Hill the strike of the sediments and underlying volcanics is parallel but the contact is not exposed. Within the sediments the sequence is the same except that the siltstones are dark gray and at the top are very slaty.

The northernmost pendant consists of a well rounded, generally clast supported polymictic conglomerate. This type of conglomerate is atypical for the rest of the map area where they are matrix supported and poorly sorted.

Mafic Rocks

Contemporaneous basic volcanicity occurs in much of the Anderson's Cove Formation. In the west of the northern belt and in the Bay L'Argent region compound diabase sills and basalt flows, up to 200 m thick and comprising as much as 40% of the sequence, interrupt the clastic sequence. They are generally massive and homogeneous or banded parallel to the strike. Variations in grain size, cleavage, epidotization, porphyroblasts and in type, concentration and size of phenocrysts and/or amygdules occur. Local erosion supplied an important clast component to overlying conglomerates. Thick concordant bodies also occur in the roof pendant zone. South and northeast of Terrenceville the basic volcanic activity is represented by mafic tuffs.

Environments of Deposition

Two contrasting environments of deposition are recognized within unit 2. Around Bay L'Argent and in the northern belt, exclusive of the roof pendants, the sediments indicate mass flow deposition into a periodically subsiding basin from local, actively rejuvenating sources. In contrast, the cleaner, predominantly sandy, crossbedded sequences at Harbour Mille, around and southwestwards from Paradise River and in the roof pendants to the north, are characteristic of a shallow water shelf environment. Facies variations and current directions, consistently from a southerly quarter, show that if their formation is approximately chronostratigraphic, the two belts must have been separate basins of deposition.

Throughout the deposition of unit 2, the area lay within an active epeirogenic tectonic regime with fault controlled source supply and basins of sedimentation.

Unit 3 (Mooring Cove Formation)

Silicic volcanic rocks conformably overlie the Anderson's Cove Formation (unit 2) in the western part of the Terrenceville map sheet. This contact relationship indicates that the volcanics are stratigraphically equivalent to the Mooring Cove Formation in the westerly adjacent Belleoram sheet (Williams, 1971).

The main lithotypes of this unit are flow banded rhyolites and massive felsites. Metabasic flows or hypabyssal rocks constitute a minor proportion of this unit and are exposed only on the north limb and core of the Femme Syncline.

Unit 4 (Rencontre Formation)

The volcanics of unit 3 are overlain unconformably by a fining-upward sequence of coarse clastics in a broad syncline around Femme Pond. Most of the sequence is gray weathering but basal beds and the finer clastics in the core of the syncline weather maroon. They overstep the lowest volcanic horizons of unit 3 in the east where thick subangular, matrix supported boulder conglomerates are dominantly massive and unbedded. These conglomerates fine westwards and northwards across the syncline. Boulders are much smaller westwards on the south flank of the syncline and absent on the north side where cobble to pebble and pebble to granule conglomerates predominate. Up sequence they become interbedded with sandstones and siltstones which are the major rock types in the core of the syncline. Towards the top of the sequence a thick felsite lava flow has been documented by Bradley, (1962).

Similar fine to medium grained red conglomerates which outcrop at the head of Fortune Bay and extend up the Terrenceville Brook valley have been tentatively correlated with the Rencontre Formation following Bradley (1962). They are interpreted to be in fault contact with the surrounding lithotypes in a graben-like structure.

Unit 5 (Terrenceville Formation)

This formation outcrops only at the community of Terrenceville and consists of well bedded brown conglomerates, red sandstones and red and pale green mudstones. The conglomerates are polymictic, matrix supported, up to cobble size with scattered boulders, rounded to subangular and commonly lensoid. Channelling is abundant, both of conglomerate into sandstone and vice versa, and more planar beds are irregular in thickness. The mudstones and sandstones bear plant remains which have been dated as Upper Devonian (Bradley, 1962). The rocks are interpreted as a fluviatile mixture of channel sandstones and conglomerates and overbank alluvial deposits.

INTRUSIVE ROCKS

Two main periods of plutonic activity can be recognized in the study area. Precambrian intrusive rocks, occurring only on the southeast side of Fortune Bay, include the pretectonic Cape Roger Mountain Batholith (Bradley, 1962) and the Deepwater Point Pluton. Paleozoic intrusions include the Ackley Granite (White, 1939) the Berry Hill Stock and the Cross Hills Batholith (Bradley, 1962). Hornblende separates from the former have been dated isotopically by the $^{40}Ar/^{39}Ar$ method at 356 ± 10 Ma. (Geochronology report, this volume).

Precambrian granitoids

The Cape Roger Mountain Batholith is a pretectonic, metamorphosed and locally strongly foliated granitoid intrusion which underlies approximately 150 km^2 of the southeastern part of the Terrenceville map area. The batholith is intrusive into volcanic rocks of unit 1a and sediments of unit 1d, and a thermal aureole of epidotization is developed.

The main phase of the batholith is a pink, medium grained biotite and hornblende granodiorite with hypidiomorphic granular to slightly porphyritic texture. Two subphases have been tentatively identified. The first is characterized by a finer grain size and a lower color index than the main phase whereas the second subphase contains mainly microgranitic to aplitic textured granitoids. Aplite dikes and gabbroic dikes and bosses constitute a minor proportion of the batholith.

The Cape Roger Mountain Batholith is strongly foliated along its eastern margin; elsewhere only weak fabrics are developed. All phases of the batholith have been metamorphosed under lower greenschist facies conditions. Biotites and amphiboles are altered to chlorite, quartz is cloudy and plagioclase is partially or completely replaced by epidote.

The Deepwater Point Pluton is a new name to be proposed for the St. Jacques Pluton of Strong *et al.*, 1974 (see O'Brien *et al.*, in prep.). It forms a 5 km^2 intrusive body which outcrops in the southeasternmost part of the Terrenceville map area. The pluton is pretectonic, containing a pervasive, inhomogeneous foliation which is strongest at its margins and in adjacent dikes.

The main intrusive phase is pink, medium grained biotite granodiorite. Fine grained granodiorite and microgranite occur near the northern contact of the body. Stringers and veins of coarse grained, muscovite-bearing granite are locally developed at the contact near Deepwater Point.

The Deepwater Point Pluton is intrusive into lithic arenites and pebble conglomerates of unit 1d south of St. Bernards. Sediments adjacent to the intrusion have been strongly epidotized in zones subparallel to the intrusive contact. The zoning in thermal metamorphic effects seen in the contact aureole may be a result of lithological control or an irregular subsurface contact between the pluton and the country rocks.

Paleozoic granitoids

The Ackley Granite is an extensive, essentially posttectonic, high level Devonian intrusion which underlies approximately 1000 km^2 of the study area, including most of the Gisbourne Lake area but only the northwestern margin of the Terrenceville area. The geology of the entire batholith is discussed by Dickson *et. al.* (this volume). A brief summary is given here.

The Ackley Granite east and north of Gisborne Lake is composed mainly of coarse to very coarse grained, porphyritic biotite granite with associated aplitic and alaskitic veins. Exposures of the batholith in the area southwest of Gisborne Lake consist mainly of coarse grained, nonporphyritic, biotite granite. Grain size decreases with proximity to the southern margin of the batholith where the major phase is pink, fine to medium grained, sparsely porphyritic, biotite granite.

The batholith is unlike other posttectonic intrusions in the map area in that it is essentially unmetamorphosed. (see Dickson *et al.*, this volume). Intrusive contacts between the batholith and thermally metamorphosed volcanics of unit 1c, sediments of the Anderson's Cove Formation and intrusives of the Cross Hills Batholith are exposed in the map area.

The Berry Hill Stock is a small granitoid body, less than 6 km^2 in area, which intrudes units 1b and 1d in the southwestern part of the Terrenceville sheet. The contact is sharp and appears to be polygonal. The stock is post-tectonic with respect to the main regional deformation and truncates earlier structures in the adjacent country rocks. It is mildly metamorphosed, however, with chlorite locally replacing ferromagnesian phases and epidote forming after plagioclase. The major intrusive phase is medium grained adamellite with subordinate amounts of granite, aplite and diabase. The stock is cut by narrow fracture zones and joints, along which fluorite mineralization locally occurs.

The Cross Hills Batholith forms an approximately 250 km^2 body north of the head of Fortune Bay. Another pluton of 30 km^2 occurs 17 km west-northwest of Terrenceville with a 4 km^2 subsidiary just to the east of it. Two smaller bodies emplaced into the Anderson's Cove Formation, 2.5 km southwest of Nine Mile Hill and 3 km north of Pin Hill respectively, are assumed to be part of the complex.

The main body is a complicated mixture of roof pendants, xenoliths, and intrusive rocks. The pendants and accidental xenoliths consist of well bedded sandstones with some siltstones, conglomerates, feldspar porphyritic or glassy rhyolitic volcanics, and diabase with rare gabbro. The intrusive xenolith assemblage is dominant. The sedimentary and volcanic xenoliths are cut by diabase dikes with chilled margins. Diabases are commonly the only rock type seen in many of the xenoliths. They are usually medium grained ophitic textured rocks but fine grained aphyric and plagioclase or plagioclase-pyroxene porphyritic varieties are also present. Locally the dikes are multiple with diabase chilled against diabase. The pendants and xenoliths are intruded, diked and net-veined by a fine to medium grained, locally foliated, granitoid which may form a separate early phase in the centre of the complex. This rock has been recrystallized (thermally metamorphosed by later phases?) destroying obvious record of the composition, grain size and foliation in many places. The gabbros are commonly foliated whereas the diabases and volcanics show little effect of the deformation or thermal metamorphism. The sediments are hornfelses and were folded prior to the thermal event which largely healed the cleavage.

The above rocks are intruded by the major granitoid phases; a medium grained hornblende granodiorite and a fine grained pink alaskite granite. The age relationship between these is not known. The hornblende granodiorite is metamorphosed, with chloritization of the ferromagnesian minerals and widespread saussuritization of feldspar. Of the accidental xenoliths diabase and volcanics are abundant in the granodiorite but small cognate(?) diorite and quartz diorite xenoliths are also common. The fine grained granite occurs along the western margin of the complex. In its northernmost part it is free of xenoliths but everywhere north and northwest of Grand Le Pierre it contains abundant diabase inclusions.

To the northwest of the main body an earlier diorite phase with country rock xenoliths is diked by a later fine-grained, pink, alaskitic granite with miarolitic cavities. Bradley (1962) referred to this body as the Bakers Pond sill. To its east the smaller body is a massive gabbro and the other intrusions are types of diorite.

STRUCTURES

The area was deformed and metamorphosed during the Acadian orogeny. The first of two ductile phases of deformation was accompanied by regional metamorphism in the greenschist facies and is largely responsible for the regional strike. It was a major inhomogeneous deformation producing a set of noncylindrical moderate to tight upright folds. Most folds occur at outcrop scale and are parasitic on map scale structures. Minor folds may be isoclinal. Axial planes are subvertical and strike approximately northeast and the folds plunge gently northeast through the horizontal to moderately southwest. A strong axial planar cleavage is developed, and folds approximate to round hinged class II structures (Ramsay, 1967).

In fine grained rocks (including unwelded vitric tuffs) alignment of phyllosilicates is completely penetrative and the cleavage is slaty. In sandy and clast-bearing rocks (including crystal and crystal-lithic tuffs) this mineral fabric is confined to the matrix components and wraps around grains and clasts, elongated in the same direction, in an anastomosing fashion. Single crystal grains (eg. quartz and feldspar) show flattening by pressure solution or lattice deformation while aggregates (eg. lithic grains and conglomerate clasts) are stretched as well as flattened. However, quartz eyes and epidotized clasts remain relatively undeformed. On a hand specimen scale these anastomosing mineral and aggregate shape fabrics are penetrative. Close slaty partings and spaced fracture cleavages always seem to parallel the penetrative fabrics. Qualitative strain studies on elongated clasts and a well developed stretching lineation, generally pitching steeply southwest in the cleavage plane, indicate a tectonic regime producing LS tectonites.

In the massive or strongly welded rhyolitic rocks deformation is only shown by spherulite flattening, feldspar tails and shard and clast fabric rotation. In places clasts in lithic pyroclastics or conglomerates with strong initial preferred orientation fail to rotate or deform enough and remain oblique to the cleavage.

The coarser grained basic rocks and the most massive conglomerates commonly resist deformation too. The Cape Roger Mountain Batholith displays only a weak fabric internally but is more strongly deformed in linear belts at or near its margins. The Deepwater Point Pluton is similarly affected. All other granitoid massifs in the area are essentially posttectonic.

Subsequent deformations were insignificant and effected only minor variations on the regional structure. The second ductile phase (folds of the cleavage) is rare, approximately coplanar with the first, occurs in fold pairs and was only seen on outcrop scale. The development of a succession of crenulations, kinks and brittle structures followed. Many of the major fault directions are sub-parallel to and enhance the regional tectonic trend.

METAMORPHISM

Dynamothermal metamorphic mineralogy is only developed during the main first phase deformation and reaches chlorite grade. Fine grained matrix and detritus in the sediments recrystallize but the coarser detrital grains and clasts are generally unaffected. Fine grained basic rocks are recrystallized to well cleaved fine grained meshes. Coarser grained varieties retain relict igneous textures with alteration to chlorite-plagioclase assemblages ± epidote and amphibole pseudomorphs of pyroxene. Metamorphism of tuffaceous rocks and clasts produces chlorite in mafic tuffs and quartz-sericite in felsic types. Alteration in massive felsic volcanics may only show as recrystallized spherulites.

Thermal metamorphism around the Precambrian intrusives occurs as various forms of epidotization. This can be either pervasive, or selectively affecting lithic grains, plagioclase crystals and the matrix, or restricted to veins and patches and rounded nodules. Epidotized rocks, clasts and nodules are resistant to the later deformation.

No aureole occurs around the Berry Hill Stock and thermal metamorphism in the Cross Hills Batholith is confined to xenoliths and alteration of some of the earlier intrusive phases. A well developed contact metamorphic aureole, locally reaching hornblende hornfels facies,is developed around the Ackley Granite.

MINERALIZATION AND EXPLORATION POTENTIAL

Chalcopyrite, galena, malachite, azurite and bornite are present in quartz veins and fractures in unit 1b volcanics along the South Shore Fault System. Very minor base metal indications are present in several other parts of unit 1 and appear to be related to the regional metamorphism of the area. Little indication of massive sulfide mineralization was found during the course of the study; however, a potential prospecting environment for such deposits might be in the interbedded volcanic and sedimentary sections of units 1a and 1d. (see Taylor *et. al.*, 1979).

Quartz veins are widespread throughout the study area, with the greatest concentration occuring in units 1b and 2. Visible mineralization is restricted to specular hematite. The possibility of gold mineralization in some of the larger veins is worthy of investigation.

Minor fluorite occurrences are related to posttectonic plutonism and are present on joint surfaces in and adjacent to the Berry Hill Stock. Fluorite occurs in float approximately 2 km south of the Ackley Granite contact at Eastern Lookout. The host rock is thermally metamorphosed rhyolite of unit 1c. The presence of molybdenite float from the same area was reported by Bradley (1962); however, *in situ* mineralization was not found.

A reconnaissance spectrometer survey of the region failed to outline any areas of significantly anomalous radioactivity.

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LOWER AND MIDDLE ORDOVICIAN CONODONTS FROM CENTRAL NEWFOUNDLAND AND THEIR CORELATIVES IN WESTERN NEWFOUNDLAND

by

Svend Stouge

INTRODUCTION

Conodonts have been known from central Newfoundland since Williams (1962) published a brief fauna list from Limestone Island west of Little Bay Island, western Notre Dame Bay (Figure 3). This was followed by a report on conodonts of Tremadoc to Lower Arenig age from South Catchers Pond (Bergström *et al.*, 1972) (Figure 1). Bergström *et al.* (1974) presented data from the Cobbs Arm Limestone and equivalent strata on New World Island, central Notre Dame Bay (Figure 4), and they recognized that the fauna covered the time interval Upper Llanvirn-Llandeilo. Further information and knowledge of conodont distribution of Lower and Middle Ordovician age was documented by Hibbard *et al.* (1977) from the Dunnage Mélange (lower Arenig) (Figure 1), by Blackwood (1978) and Stouge (1979a; in press) from the Davidsville Group (Upper Llanvirn-Llandeilo) and by Kean (1979) from the Buchans area (Upper Llanvirn-Llandeilo). Hunter (1978) presented a complete taxonomical description of the conodont fauna from New World Island.

This information, with additional knowledge on conodont distribution presented here, forms the basis for the recognition and dating of faunas associated with volcanic rocks and their correlation with faunas from the carbonate platform sequence of the Great Northern Peninsula.

The stratigraphy of Notre Dame Bay has recently been outlined by Dean (1977, 1978), and his terminology is applied to this report.

PROVINCIALISM AND COMPOSITION OF CONODONT FAUNAS

Conodonts were influenced by provincialism throughout most of the Ordovician Period (*e.g.* Barnes & Fåhraeus, 1975). The two principal provinces are referred to as the Midcontinent Fauna Province and the North Atlantic Fauna Province. Two separate stratigraphic standard references, one for each province, are in use (Figure 2).

The majority of the fauna elements identified from central Newfoundland are of North Atlantic Fauna Province affinities. A minor part belongs to the Midcontinent Fauna Province. One assemblage includes species which so far are unknown from the North Atlantic region. Correlation can be readily made with European conodont successions (Lindström, 1971; Bergström, 1971), whereas correlation to the North American Midcontinent sequences (Ethington & Clark, 1971; Sweet *et al.*, 1971) is more uncertain. Some of the correlations between the volcanic terrane and the carbonate platform terrane can be made using mixed faunas from slope deposits of the Cow Head Group.

UPPER TREMADOC TO LOWER ARENIG AGE (Figure 1)

At South Catchers Pond (Figure 1) trilobites (Dean, 1970) and conodonts (Bergström *et al.*, 1972) have been recorded in bedded and conglomeratic limestones of the Catchers Pond Group (Neale & Nash, 1963; Dean & Strong, 1975). The conodont fauna includes

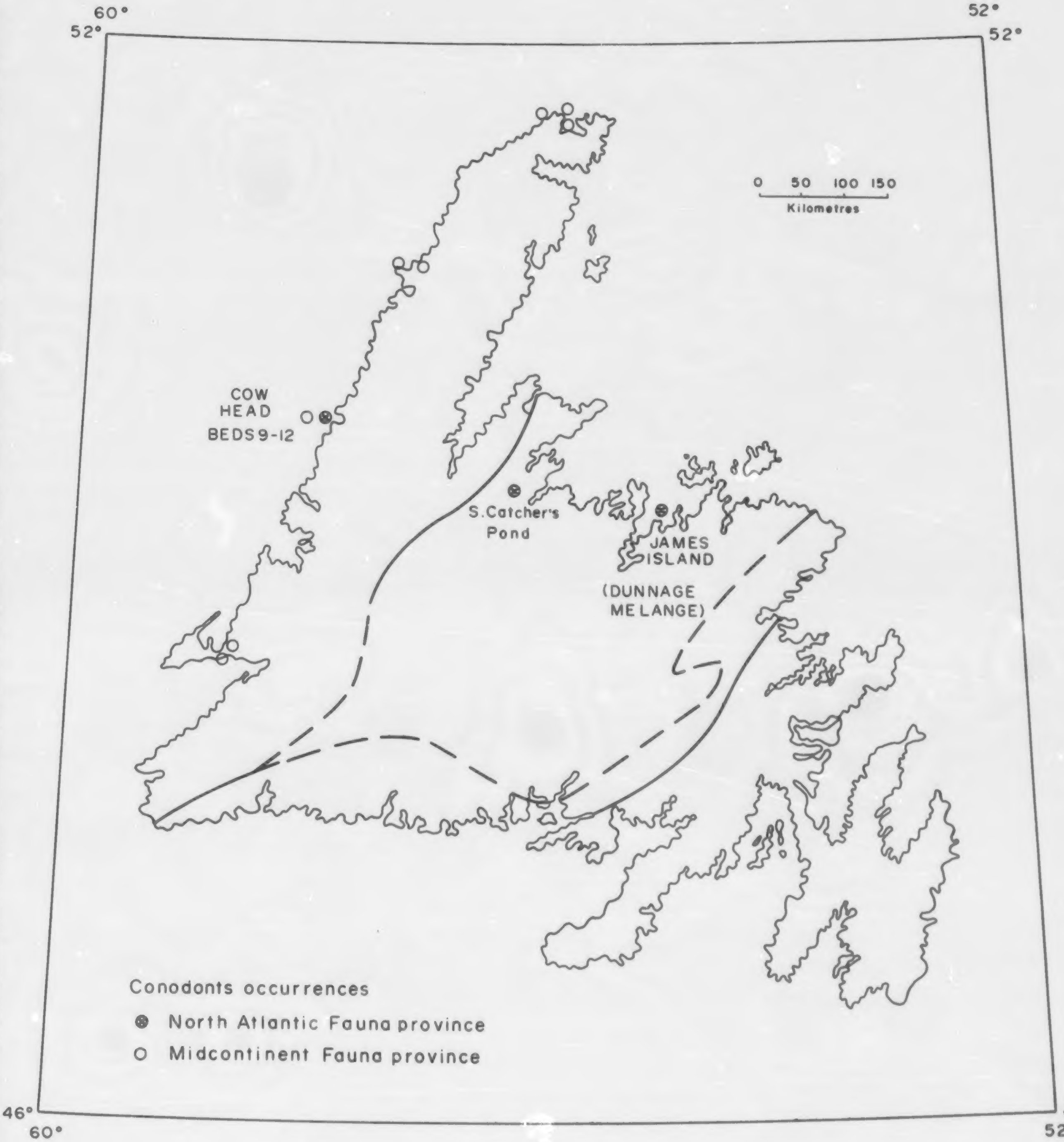
60°
52°
52°
52°
0 50 100 150
Kilometres
COW
HEAD
BEDS 9-12
S. Catcher's
Pond
JAMES
ISLAND
(DUNNAGE
MELANGE)
Conodonts occurrences
⊗ North Atlantic Fauna province
○ Midcontinent Fauna province
46°
60°
46°
52°

Figure 1. Distribution of Tremadoc-Arenig (Canadian) conodont localities in central Newfoundland and their known correlatives on the Great Northern Peninsula.

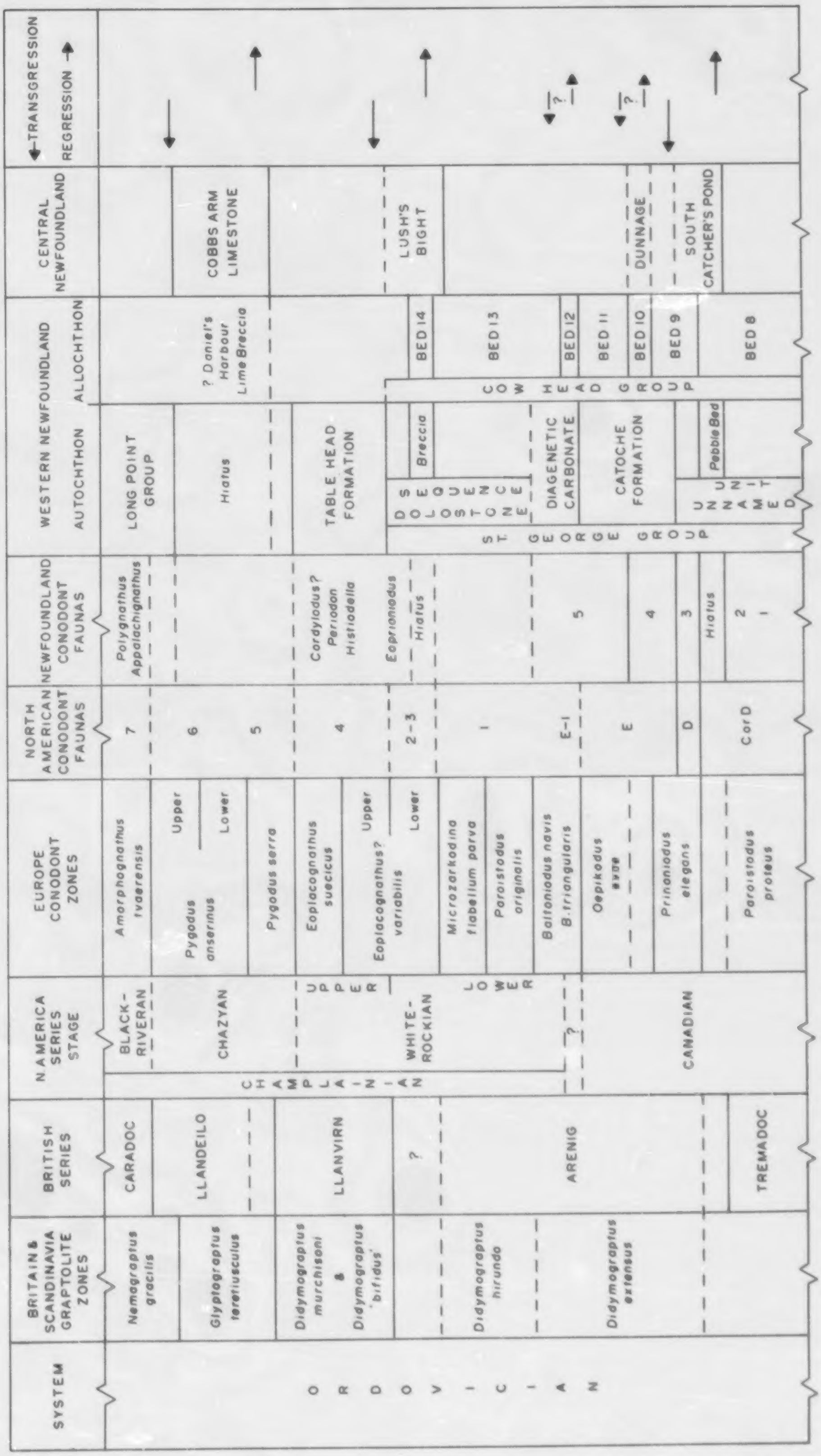
SYSTEM
ORDOVICIAN
BRITAIN & SCANDINAVIA GRAPTOLITE ZONES
Nemagraptus gracilis
Glyptograptus teretiusculus
Didymograptus murchisoni & Didymograptus 'bifidus'
Didymograptus hirundo
Didymograptus extensus
BRITISH SERIES
CARADOC
LLANDEILO
LLANVIRN
?
ARENIG
TREMADOC
N AMERICA SERIES STAGE
BLACK-RIVERAN
CHAZYAN
UPPER
WHITE-ROCKIAN
LOWER
?
CHAMPLAINIAN
CANADIAN
EUROPE CONODONT ZONES
Amorphognathus tvaerensis
Pygodus anserinus
Upper
Lower
Pygodus serra
Eoplacognathus? suecicus
Eoplacognathus? variabilis
Upper
Lower
Microzarkodina flabellum parva
Paroistodus originalis
Baltoniodus navis
B. triangularis
Oepikodus evae
Prioniodus elegans
Paroistodus proteus
NORTH AMERICAN CONODONT FAUNAS
7
6
5
4
2-3
1
E-1
E
D
C or D
NEWFOUNDLAND CONODONT FAUNAS
Polygnathus
Appalachignathus
Cordylodus?
Periodon
Histiodella
Eoprioniodus
Hiatus
5
4
3
Hiatus
2
1
WESTERN NEWFOUNDLAND
AUTOCHTHON
LONG POINT GROUP
Hiatus
TABLE HEAD FORMATION
Breccia
DOLOSTONE SEQUENCE
DIAGENETIC CARBONATE
CATOCHE FORMATION
Pebble Bed
UNNAMED
UNIT
ST. GEORGE GROUP
ALLOCHTHON
? Daniel's Harbour Lime Breccia
BED 14
BED 13
BED 12
BED 11
BED 10
BED 9
BED 8
COW HEAD GROUP
CENTRAL NEWFOUNDLAND
COBBS ARM LIMESTONE
LUSH'S BIGHT
DUNNAGE
SOUTH CATCHER'S POND
TRANSGRESSION
REGRESSION
?
?

Figure 2. Correlation of stratigraphic units in western and central Newfoundland and their ranges in terms of North American and British standard units as indicated by conodonts. Note that the central Newfoundland carbonate deposits apparently are pretransgressive.

Prioniodus elegans Pander which is the zonal fossil of the Scandinavian conodont zonal succession (Lindström, 1971) (Figure 2). *P. Elegans* condont zone is uppermost Tremadoc to Lower Arenig in age (Bergström *et al.*, 1972).

Prioniodus elegans has also been recorded from Beds 9 and 10 of the Cow Head Group, western Newfoundland (Fahraeus & Nowlan, 1978). These beds tentatively correlate with conodont faunas 3 and 4 of an unnamed unit and the Catoche Formation of the St. George Group (Stouge, in press). Conodont faunas 3 and 4 are assigned to Midcontinent fauna D and part of Midcontinent fauna E (Upper Canadian) of the North American fauna succession (Ethington & Clark, 1971) (Figure 2).

The Dunnage Mélange at James Island (Figure 1) has yielded a small conodont faunule. Other fossils include Cambrian trilobites (Kay & Eldredge, 1968) and Tremadocian graptolites (Hibbard *et al.*, 1977). The conodonts, in contrast, are of Lower Arenig age (*Oepikodus evae* conodont Zone-Figure 2).

In western Newfoundland *Oepikodus evae* (Lindström) is present in Bed 11 and 12 in the Cow Head Group (Fåhraeus & Nowlan, 1978). Beds 11 and 12 are tentatively correlated with conodont faunas 4 and 5 from the Catoche Formation (Stouge, in press). This is Midcontinent fauna E (Upper Canadian) (Figure 2).

UPPER ARENIG TO LOWER LLANVIRN AGE (Figure 3)

The Cutwell Group on Long Island and the correlative Western Arm Group on Limestone Island (Dean, 1977, 1978) (Figure 3) include fossiliferous limestones. The limestones are bedded or conglomeratic and interbedded with graywackes and tuffs. The macrofossils include crinoids, brachiopods, gastropods and cephalopods (Williams, 1962; Strong & Kean, 1972). The shelly fossils have not yet been described, but were indicative of an Upper Arenig age.

Abundant conodont elements are recorded, but most of the species are new. Genera of the North Atlantic and the Midcontinent Fauna provinces are present. Several forms, however, cannot definitively be included in the current recognized major faunal provinces (Stouge, 1980).

The fauna includes *Periodon flabellum-P. aculeatus*, *Polonodus sp.* and *Cordylodus ? horridus*. Compositionally, the genera are similar to those of the Table Head Formation (Upper Whiterock) of western Newfoundland, but the species are either new or slightly older (Stouge, 1980). The phyletic evolutionary stage of *Periodon* is the same as the one described from Bed 13 and 14 in the Cow Head Group by Fåhraeus & Nowlan (1978). The association of species is indicative of an Upper Arenig-Lower Llanvirn age (Lower Whiterock). The fauna correlates with *Microzarkodina parva* and *Eoplacognathus? variabilis* conodont zones (Figure 2).

UPPER LANVIRN TO LLANDEILO AGE (Figure 4)

The Cobbs Arm Limestone, New World Island (Fig. 4), overlies the Summerford Group and it is overlain by Caradocian shales (Dean, 1977, 1978). The limestone has yielded brachiopods (Neumann, 1976) and trilobites (Dean, 1971, 1976) as well as a profuse conodont fauna (Bergström et al., 1974; Hunter, 1978).

The recorded conodont faunas cover the *Pygodus serra-P. anserinus* conodont zones which are Upper Llanvirn-Llandeilo age (Bergström, 1971; Bergström *et al.*, 1974) (Figure 2). In terms of the North American succession this corresponds to Midcontinent Faunas 5-6 (Sweet *et al.* 1971) or Chazyan.

Additional collections from various localities from central Newfoundland (Figure 4) were all indicative of and correlative with the faunas of the Cobbs Arm Limestone. These localities include

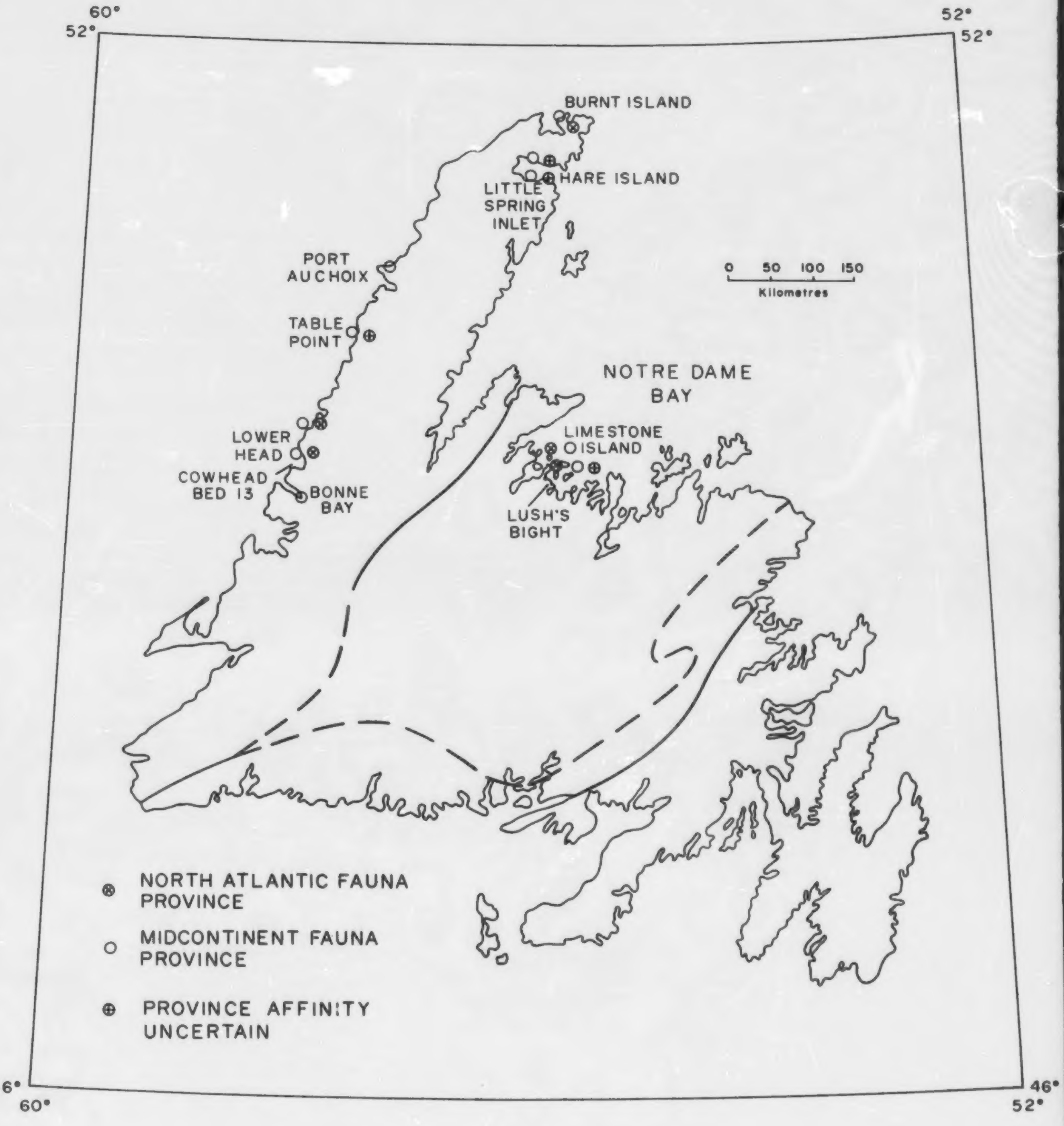
60°
52°
52°
52°
BURNT ISLAND
HARE ISLAND
LITTLE SPRING INLET
PORT AUCHOIX
TABLE POINT
0 50 100 150
Kilometres
NOTRE DAME BAY
LOWER HEAD
COWHEAD BED 13
BONNE BAY
LIMESTONE ISLAND
LUSH'S BIGHT
⊗ NORTH ATLANTIC FAUNA PROVINCE
○ MIDCONTINENT FAUNA PROVINCE
⊕ PROVINCE AFFINITY UNCERTAIN
46°
60°
46°
52°

Figure 3. Distribution of Upper Arenig - Lower Llanvirn conodont localities, central Newfoundland and their known correlatives on the western platform.

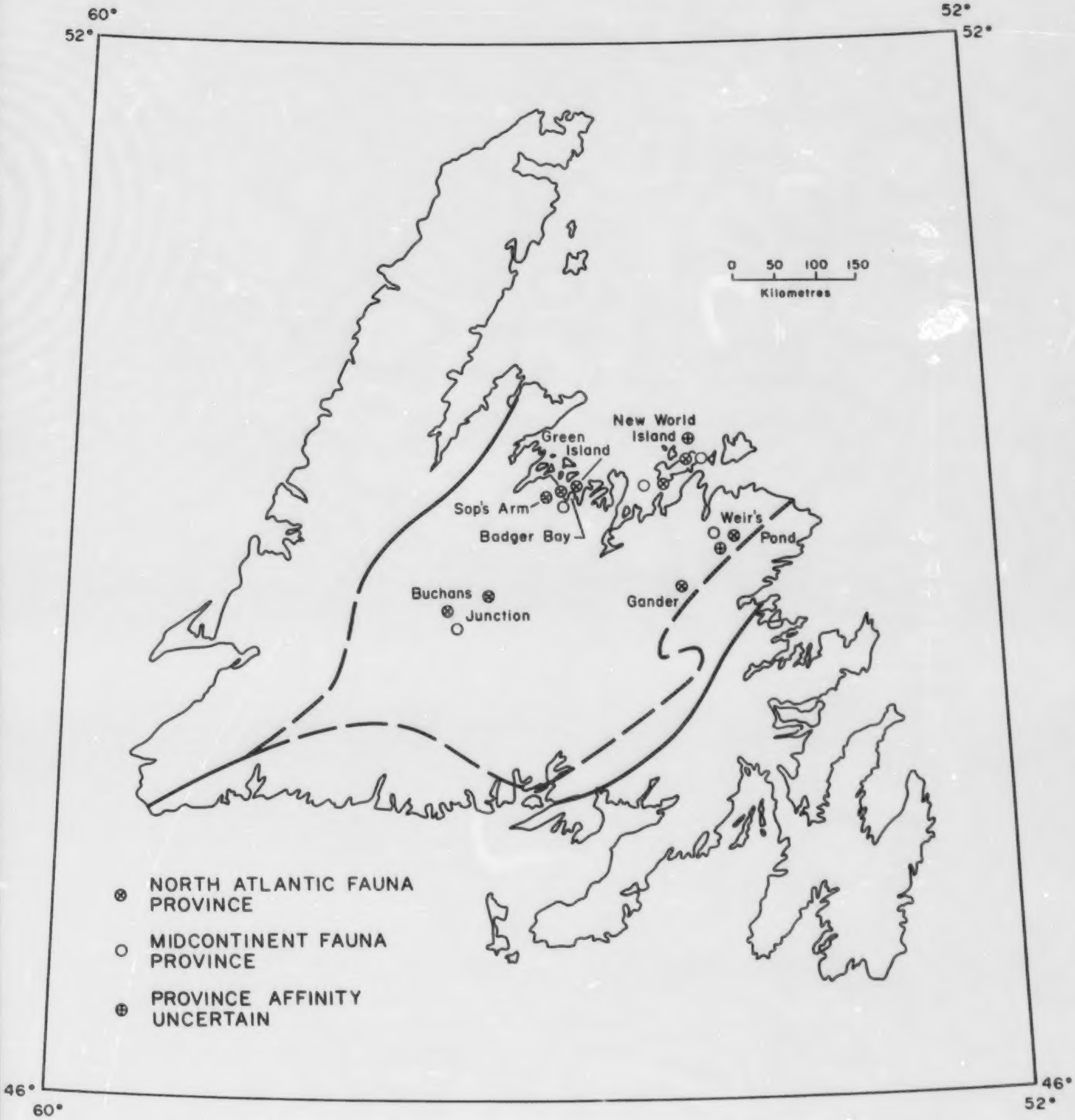
60°
52°
52°
52°
0 50 100 150
Kilometres
New World Island
Green Island
Sop's Arm
Badger Bay
Weir's Pond
Buchans
Junction
Gander
⊗ NORTH ATLANTIC FAUNA PROVINCE
○ MIDCONTINENT FAUNA PROVINCE
⊕ PROVINCE AFFINITY UNCERTAIN
46°
60°
46°
52°

Figure 4. Upper Llanvirn - Llandeilo conodont localities in central Newfoundland.

limestones from the base of the Davidsville Group at Weir's Pond (Stouge, 1979a; in press) and from the Buchans junction Area (Kean, 1979).

Limestone boulders collected from the Sops Head Complex in Sops Arm, the Badger Bay area, and from the Boones Point Complex at Green Island (Figure 4) yielded conodonts of similar composition to those in the Cobbs Arm Limestone. The limestone boulders may have been derived from the Cobbs Arm Limestone or lateral equivalent strata.

SUMMARY

Three Ordovician limestone units in central Newfoundland have yielded conodonts. The ages straddle the boundaries of the following Ordovician series: Tremadoc-Arenig, Arenig-Llanvirn, Llanvirn-Llandeilo.

The conodont faunas can be indirectly correlated with those of the western platform, Great Northern Peninsula, and directly with the European faunas and faunas from the slope deposits along the western margin of the ancient North American craton. The Tremadoc-Arenig fauna correlates with Beds 9 and 10 of the Cow Head Group. Part of this time interval correlates with a disconformity which has been recognized at the base of the Catoche Formation (Knight, 1978; Boyce, 1979) and elsewhere (Stouge, in press). The Upper Arenig-Lower Llanvirn age fauna shares species with Beds 13 and 14 of the Cow Head Group and genera with the Table Head Formation (Upper Whiterock). In western Newfoundland this time interval has traditionally been recognized as an important disconformity (Schuchert & Dunbar, 1934, and others). The youngest fauna so far has no contemporaneous shelly fauna on the western platform. The neoautochthonous Long Point Group (upper *Pygodus anserinus* to *Amorphognathus tvaerensis* zones; Fåhraeus, 1973) is slightly younger (Bergström *et al.*, 1974).

The distribution of the faunas is that the oldest one has only been recorded from a restricted area in northwest-central Newfoundland. The middle fauna has been recorded only from two localities in northwestern Notre Dame Bay. The youngest fauna is recorded from widely distributed localities across central Newfoundland extending from Sops Arm in the west to Weir's Pond in the east and from the Buchans area to the southwest.

ACKNOWLEDGEMENTS

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GEOCHRONOLOGY REPORT

An ongoing program of radiometric dating was initiated by the Department of Mines and Energy in 1977 to assist the regional mapping programs in Newfoundland and Labrador. The data obtained, in addition to hopefully providing the age of rock units and mineralization, were also intended to provide information on uplifts and cooling, and to aid in the interpretation of the evolution of magmas based on initial $^{87}Sr/^{86}Sr$ ratios.

Three dating techniques were employed, namely Rb/Sr, U/Pb, and $^{40}Ar/^{39}Ar$.

The insular Newfoundland program is being co-ordinated by Dr. R. D. Dallmeyer of the University of Georgia, Athens. Dr. Dallmeyer completed the $^{40}Ar/^{39}Ar$ analyses, and Dr. A. L. Odom of Florida State University, Florida, the Rb/Sr and U/Pb analyses. Dr. Dallmeyer supervised sample collection in the field.

The initial program in Labrador was conducted by D. Kontak as part of an M.Sc. study under the supervision of Drs. H. Baadsgaard and R. Morton at the University of Alberta and was confined to Rb/Sr and U/Pb dating. The geochronology program was expanded in 1978 and Rb/Sr whole-rock dating was carried out by Dr. C. Brooks of the University of Montreal. In addition, $^{40}Ar/^{39}Ar$ investigations were conducted on rocks of the eastern Central Mineral Belt by Drs. D. Archibald and E. Farar of Queen's University, Kingston, and on rocks of the southern Labrador Trough by Dr. R. D. Dallmeyer. In these cases, sample collection was done under the guidance of the geochronologist.

The results and interpretations presented here (table 1 and 2) are preliminary, and more detailed discussions of the data will appear later in the Department's "Preliminary Report" series.

UNIT	METHOD	DATE (Ma)	INTERPRETATION
Burlington Granodiorite	1. Rb-Sr whole rock isochron 2. U-Pb zircon concordia	494 ± 39 461 ± 15	1 & 2 suggest emplacement at approximately 475 ± 15 Ma.
	3. ^{40}Ar/^{39}Ar (hornblende) 4. ^{40}Ar/^{39}Ar (biotite)	464 ± 5 pluton margin 406 ± 5 pluton interior 414 ± 10 interior 414 ± 5 interior 412 ± 5 409 ± 10	Indicates rapid cooling at pluton margin. Postmagmatic cooling in central portions of pluton where hornblende (3) and biotite samples (4) record similar dates.
Dunamagon Granite	1. U/Pb zircon concordia 2. ^{40}Ar/^{39}Ar (biotite)	460 ± 20 344 ± 5	Indicates older emplacement age than previous dates (~425). Biotite date is markedly younger than previously published Rb-Sr and U-Pb dates of approximately 425 Ma. The biotite age probably dates time of postmetamorphic cooling.
Mings Bight and Pacquet Harbour Groups	1. ^{40}Ar/^{39}Ar (hornblende)	345 - 362	Probably postmetamorphic cooling dates.
Swift Current Pluton	1. Rb-Sr whole rock isochron	548 ± 11	Slight discrepancy with U-Pb age may indicate postmagmatic heating.
	2. U-Pb zircon concordia	580 ± 20	Best date for time of emplacement.
	3. ^{40}Ar/^{39}Ar (hornblende)	560 ± 15 566 ± 15	Closeness in age to U-Pb date suggests pluton emplacement at shallow crustal level and rapid postmetamorphic cooling.
Love Cove Volcanics	1. U-Pb zircon concordia 2. U-Pb zircon concordia	590 ± 30 608 ± 25	Age for volcanics; similarity to Swift Current Pluton age supports field evidence indicating volcanics are extrusive equivalents of plutonics.
Bull Arm Rhyolite	1. U-Pb zircon	584 minimum	Samples unsuitable to yield a concordia age.
Ackley Granite	1. ^{40}Ar/^{39}Ar (biotite) (hornblende)	352 ± 10 355 ± 10 356 ± 10	Dates are similar to previously published Rb-Sr date of 354 ± 8 suggesting rapid postmagmatic cooling. Since pluton is essentially unmetamorposed, the date provides an upper limit for Love Cove metamorphism.
Love Cove Phyllites	1. ^{40}Ar/^{39}Ar (whole rock)	380 - 388 (6 samples) 353 - 367 (3 samples)	Dates time of regional metamorphism.
Chetwynd Granite	1. U-Pb zircon	377 ± 20	Date of emplacement
	2. ^{40}Ar/^{39}Ar (biotite) (hornblende)	(S) 372 ± 5 (N) 350 ± 5 (N) 361 ± 5	Cooling dates for granite (S) Samples south of Bay d'Est Fault. (N) Samples north of Bay d'Est Fault Indicates more rapid cooling south of fault.
La Poile Batholith	1. ^{40}Ar/^{39}Ar (biotite) 2. ^{40}Ar/^{39}Ar (hornblende)	360 ± 5 380 ± 5	Cooling age of granite. Similar to postmetamorphic cooling age of Bay du Nord Group.
Hawks Nest Pond Porphyry (La Poile Group).	1. U-Pb zircon	410 ± 20	Emplacement of porphyry.
Bay du Nord Group Dolman Formation	1. U-Pb zircon	449 ± 20	Age for volcanics.
Metasediments	2. ^{40}Ar/^{39}Ar (biotite) (biotite)	343 ± 5 353 ± 5	Dates postmetamorphic cooling or uplift and cooling.
Amphibolite	3. ^{40}Ar/^{39}Ar (biotite) (hornblende)	377 ± 5 388 ± 5	
Rose Blanche granodiorite/tonalite	1. ^{40}Ar/^{39}Ar (hornblende)	392 ± 10	Dates cooling.
Lockers Bay Granite	1. U-Pb zircon concordia	460 ± 20	Age of emplacement of granite. Markedly older than previously published Rb-Sr age of 300 ± 18 Ma.

TABLE 1

ROCK UNIT OR MINERALIZATION	METHOD	DATE (Ma)	INTERPRETATION
Central Mineral Belt - Eastern			
Pegmatite associated with Benedict Granodiorite	^{40}Ar/^{39}Ar (Archibald & Farrar) plateau age, muscovite	1630 ± 10	Interpreted as age of emplacement of Benedict Granodiorite - similar to Walker Lake Granodiorite supporting contention that these two batholiths are related.
Walker Lake Granodiorite	^{40}Ar/^{39}Ar (Archibald & Farrar) (a) plateau age, biotite (b) plateau age, hornblende (c) total fusion, biotite	2450 ± 15 1308 ± 10 1750 ± 10	(a) old age due to excess argon. (b) hornblende spectrum is disturbed, possibly due to inherited argon. (c) may date emplacement or may be disturbed due to inherited argon.
Major shear zone in Walker Lake - Benedict granodiorite	^{40}Ar/^{39}Ar (Archiblad & Farrar) total fusion, biotite	1004 ± 5	Shear zone was developed during the Grenvillian Orogeny.
Walker Lake granite	Rb-Sr whole rock isochron (Brooks)	1595 ± 34	Interpreted as age of emplacement..
Walker Lake granite	Rb-Sr whole rock isochron (Kontak)	1550 ± 50	Errorchron - upper limit of 1650. Data is compatible with Brook's age.
Foliated granite	Rb-Sr whole rock isochron (Brooks)	1795 ± 50	Interpreted as age of emplacement.
Upper Aillik Group felsic volcanics	Rb-Sr whole rock ischron (Kontak)	1767 ± 4	Interpreted as extrusive age.
Kitt's uranium deposit	U-Pb, pitchblende (Kontak)	1770	Indicates age of mineralization.
Burnt Lake Uranium deposit	U-Pb, pitchblende (Kontak)	1770	Probable age of mineralization, although there are variations in the U-Pb systematics.
Central Mineral Belt - Central			
Nebulitic granodiorite (Island Hr. Granite)	Rb-Sr whole rock isochron (Brooks)	1350 ± 200	"Errorchron": does not provide a precise age due to internal complexities in the granite and Rb-Sr systematics not obvious from the field specimens.
Bruce River Group volcanics at Bruce Lake	Rb-Sr whole rock isochron (Kontak)	1527 ± 39	Interpreted as extrusive age.
Bruce River Group volcanics at Minisinakwa Lake	Rb-Sr whole rock isochron (Kontak)	1538 ± 25	Geologically resaonable age in light of previous Rb-Sr data.
Otter Lake granite	Rb-Sr whole rock isochron (Kontak)	1496 ± 37	Intrudes the Bruce River Group. Age of crystallization.
Moran Lake "B" zone Uranium showing	U-Pb, brannerite (Kontak)	1785	Considered to be remobilized U from older rocks, since U occurs in leucogabbro dikes cutting the Bruce River Group.
Moran Lake "C" zone Uranium showing	U-Pb, pitchblende (Kontak)	1540	Epigenetic mineralization associated with carbonate altered rocks of the lower Bruce River Group.
Stormy Lake Uranium showing	U-Pb, pitchblende (Kontak)	860 - 990	Widely scattered data points, but suggests veins a product of Grenvillian deformation. Some hint of lead contamination ca. 500 Ma.

TABLE 2

ROCK UNIT OR MINERALIZATION	METHOD	DATE (Ma)	INTERPRETATION
Central Labrador Trough			
Shabogamo Intrusive Suite	Rb-Sr whole rock isochron (Brooks)	15 point 1685 ± 60	Errorchron based on combination of three separate isochrons determined for 3 separate sample sites. 1690 ± 50, 1695 ± 60, and a third isochron of 1040 ± 40, which is due to Grenville alteration. Altered samples were excluded from this ischron before combination with other isochrons. - Total rock errorchron probably good and reflects age of intrusion.
Blueberry Lake group	Rb-Sr whole rock isochron (Brooks)	1540 ± 40	Result is an errorchron and indicates either heterogeniety of initial Sr in samples or later alteration and redistribution of Sr^{87}. The age currently appears to be too young since the unit is believed to be intruded by the Shabogamo Intrusive Suite.
Southern Labrador Trough			
Shabogamo Intrusive Suite	Rb-Sr whole rock isochron (Brooks)	945 ± 180	Age of Grenvillian metamorphism.
	Rb-Sr whole rock isochron (Brooks)	935 ± 60	Age of Grenvillian metamorphism.
	Rb-Sr whole rock isochron	1570 ± 180	Age of emplacement.
Attikamagen Formation	Rb-Sr whole rock isochron (Brooks) Rb-Sr slabbed sample (Brooks) Rb-Sr slabbed sample (Brooks)	1450 ± 350 1190 ± 400 960 ± 350	"Errorchrons", significance of older age not fully understood. Younger ages indicate Grenvillian Orogeny.
Ashuanipi Metamorphic Complex (Grenville Province)	^{40}Ar/^{39}Ar (Dallmeyer)	2393 ± 20	Post-Kenoran cooling age.
Ashuanipi Metamorphic Complex (Grenville Province)	^{40}Ar/^{39}Ar biotite (Dallmeyer)	2093 ± 2	Disturbed spectrum - post-Kenoran cooling age partially reset during Grenvillian Orogeny.
Shabogamo Intrusive Suite	^{40}Ar/^{39}Ar - hornblende (Dallmeyer)	919 ± 15	Post Grenvillian cooling age - no evidence of Hudsonian Orogeny.
	^{40}Ar/^{39}Ar - biotite (Dallmeyer) ^{40}Ar/^{39}Ar - hornblende (Dallmeyer)	980 ± 15 1044 ± 15	Post Grenvillian cooling age - no evidence of Hudsonian Orogeny.
	^{40}Ar/^{39}Ar - biotite (Dallmeyer) ^{40}Ar/^{39}Ar - hornblende (Dallmeyer)	889 ± 15 928 ± 15	Post Grenvillian cooling - no evidence of Hudsonian Orogeny.
Menihek Formation	^{40}Ar/^{39}Ar - biotite (Dallmeyer)	940 ±15	Post Grenvillian cooling age - no evidence of Hudsonian Orogeny.
Davis Inlet Area			
Char Lake monzonite	Rb-Sr whole rock isochron (Brooks)	1325 ± 55	Errorchron - Approximate age of crystallization.
Pyroxene granite	Rb-Sr whole rock isochron (Brooks)	1217 ± 24	Isochron - Approximate age of crystallization.
Peralkaline granite	Rb-Sr whole rock isochron (Brooks)	835 ± 50	Errorchron - Possible age of crystallization.
Felsic volcanics	Rb-Sr whole rock isochron (Brooks)	470 ± 120 (?)	Errorchron - No meaningful age data.
Flowers Bay Anorthosite	Rb - Sr whole rock isochron (Brooks)	1200 ± 210	Errorchron - Very approximate age of crystallization.

TABLE 2 (Cont.)

PRELIMINARY RECONNAISSANCE STUDY OF THE NORTHERN GRENVILLE PROVINCE, NASKAUPI RIVER AREA, LABRADOR

by

Bruce Ryan

INTRODUCTION

The author did not undertake an extensive field program during 1979, being in the process of compiling the results of geological studies conducted in the Central Mineral Belt between 1974 and 1978. However, a helicopter-supported reconnaissance survey was carried out from Goose Bay for a five-day period during the last week of July to evaluate the feasibility of initiating a program along the northern margin of the Grenville Province in the Grand Lake - Naskaupi River area in 1980. The main reasons for the initial reconnaissance work were the possibility of finding unrecognized metavolcanic rocks of the Bruce River Group in the area south of Nipishish Lake (cf. Ryan and Harris, 1978), and the reported occurrence of Seal Lake Group rocks in the Mount Elizabeth area (Stevenson, 1967) near a regional uranium reconnaissance program (URP) anomaly detected in 1977.

The mapping carried out in 1979 was concentrated in the Crooked River - Naskaupi River - Grand Lake area, and included the southern halves of N.T.S. areas 13K/2 and 3, and all of N.T.S. areas 13F/14 and 15. Previous work had shown the northwest portion of the study area (13K/3) to be underlain by the Seal Lake Group in fault contact with foliated granites to the south (Fahrig, 1959) and the northeast portion (13K/2) to be underlain by granite and paragneiss (Williams, 1970). The other two map areas (13F/14 and 15) were shown on Stevenson's (1967) map as being underlain chiefly by "black and white gneisses and gneissic granite of probable sedimentary origin", with an east-west trending belt of metaquartzites in the vicinity of Mount Elizabeth and another ovoid area on the north side of the Red Wine River. The major finding of the study was the recognition of Williams' (1970) "paragneiss" and Stevenson's (1967) "metaquartzite" as aplite and microgranite similar to that of the Nipishish Lake area described by Ryan and Harris (1978). The presence of these fine grained rocks and their intrusive nature were documented earlier by Fahrig (1959), but the rocks were not differentiated from the coarser types on his map.

Figure 1 is a preliminary reconnaissance map and many of the rock type boundaries are uncertain. However, comparing Figure 1 with previous regional maps shows that there are major changes in lithological distribution within the area. The present study has shown that rocks previously mapped as gneisses are, in fact, variably foliated granites. Only rocks which exhibit a distinct compositional layering are designated "gneiss" on the present map. The granitoids commonly show one fabric which is, in places, very strongly developed. However, pretectonic pegmatite and aplite dikes and local *in situ* syntectonic granitic mobilizate occur in the more intensely deformed granites and, when parallel to the foliation, give the rock a gneissic appearance.

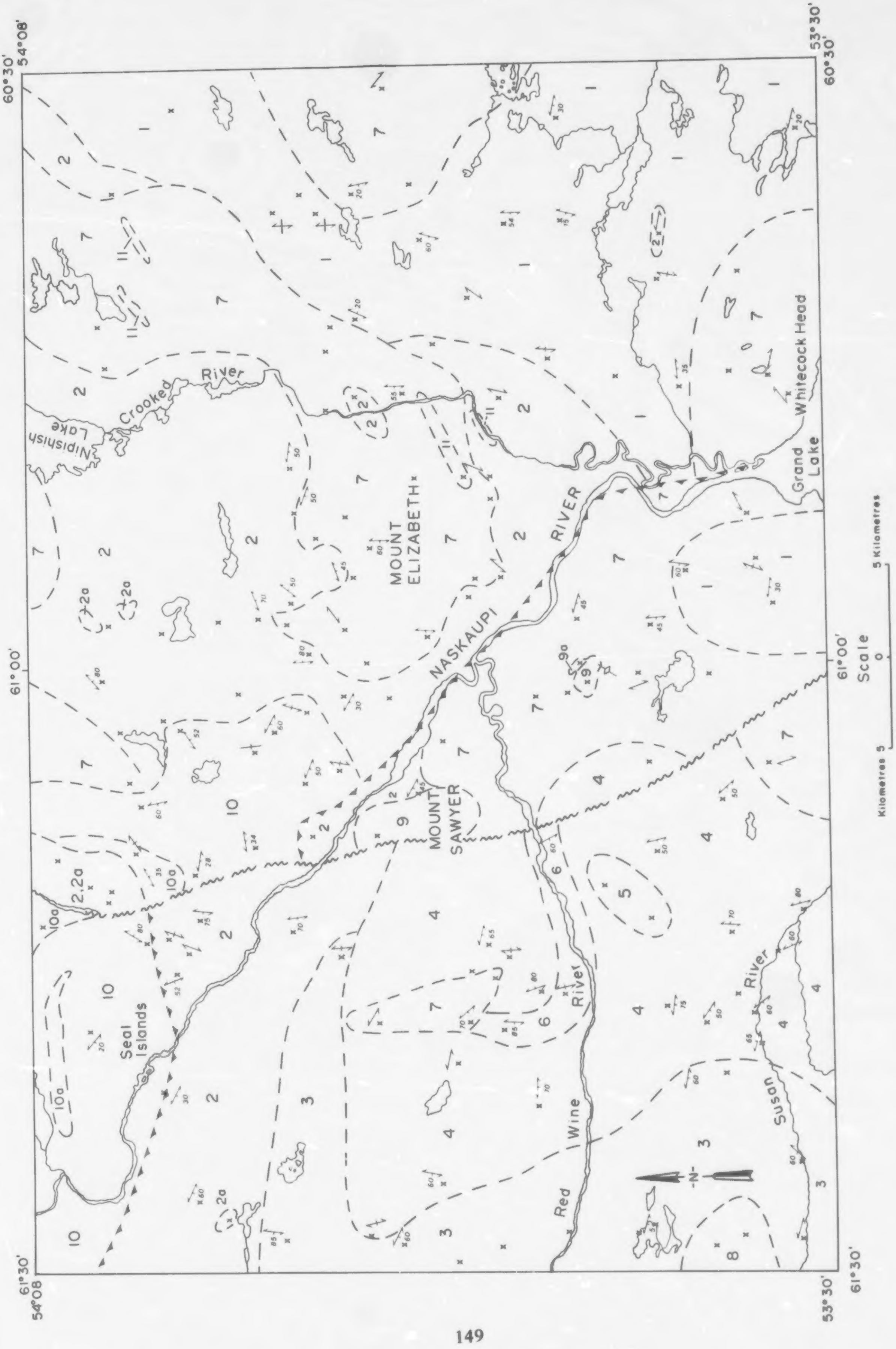
GENERAL GEOLOGY

Banded Gneiss (1)

Medium grained, well banded, white weathering biotite ± epidote gneiss with

LEGEND

11	Michael gabbro
10	Seal Lake Group: quartzite; 10a, metabasalt
9	Anorthosite; 9a, ultramafic rocks
8	Diorite
7	Medium grained biotite granite, microgranite, aplite
6	Garnetiferous leucodiorite
5	Pink granite
4	Biotite granite
3	Megacrystic granodiorite
2	Monzonite and granodiorite; 2a, diorite
1	Biotite gneiss and amphibolite


61°30'
54°08'
60°30'
54°08'
61°00'
60°30'
53°30'
61°30'
53°30'
61°00'
Nipishish Lake
Crooked River
MOUNT ELIZABETH
NASKAUPI RIVER
Grand Lake
Whitecock Head
MOUNT SAWYER
Seal Islands
Red Wine River
Susan River
N
Scale
Kilometres 5
0
5 Kilometres

local granular garnetiferous amphibolite units occupies a north-trending lobe east of the Crooked River and west of Grand Lake. These rocks exhibit varying degrees of remobilization and migmatization manifested in the field as agmatitic, schlieric, dictyonitic and nebulose variations of the well banded character. Most of the mobilizate component in these rocks appears to be a result of *in situ* processes. Irregular, small quartzofeldspathic zones have biotite-rich selvedges and, characteristically, the subconcordant neosome granitic vein network contains stubby hornblende prisms. Locally, the gneissic layering is folded by open, gently south-plunging folds. Scintillometer (SCINTREX BGS-1, total count) values vary from 50 to 150 cps over this unit, with the average being in the order of 100-110 cps. A few rusty, pyritic seams were noted, but are of limited extent.

Granitic and Dioritic Rocks (2-8)

Most of the area is underlain by a variety of granitic rocks varying from very coarse megacrystic types to very fine, granular, microgranite and aplite. Minor amounts of diorite are also present locally. Relative ages of all these units could not be established from this survey, but the aplitic granites appear to be among the youngest (*cf*. Ryan and Harris, 1978).

Medium to coarse grained, white weathering monzonite and biotite ± hornblende granodiorite (2) belonging to the Otter Lake Granite (Ryan and Harris, 1978) outcrops south of Nipishish Lake and along the Naskaupi River. The monzonitic phase is intrusive into the granodioritic phase. This granite commonly displays a mottled, greenish aspect due to saussuritization of plagioclase and the development of epidote after biotite. Locally, it includes significant amounts of earlier gabbro and diorite (2a). The granite is inhomogeneously deformed, varying from massive to strongly schistose. Measured scintillometer values range between 80 and 150 cps, with most between 90 and 100 cps.

Very coarse grained megacrystic granodiorite (3) outcrops with an annular and lobate pattern along the western margin of the map area in the vicinity of the Susan and Red Wine Rivers; it corresponds to the "porphyritic veined augen gneiss" of Stevenson (1967). This granitic body is composed of pink, twinned microcline(?) megacrysts up to several centimetres in maximum dimension in a medium grained matrix of quartz, feldspar and biotite. In several outcrops, hornblende was observed as a matrix phase accompanied by small red garnets. Lensoid basic inclusions occur locally. This granite varies from undeformed to augen textured to strongly schistose, the megacrysts changing from subhedral, to rounded and ovoid, and to lensoid streaks in response to the deformation. Such variations have been noted in single outcrops and reflect the inhomogeneity of deformation. Scintillometer values recorded from this unit ranged from 100-140 cps, with most around 100 cps.

A large area in the vicinity of the Susan and Red Wine Rivers is underlain by a gray to white weathering, medium to coarse grained, locally feldspar-porphyritic, biotite granite (4); hornblende and garnet may be present. Texturally, it varies from nearly undeformed to schistose to gneissic. It is well exposed along the Susan River, where some outcrops display a strongly gneissose character due to flattening of aplite and pegmatite dikes parallel to the foliation; other outcrops display a foliated character with *in situ* quartz-feldspar melt occupying dilation fractures slightly oblique to the foliation. In some outcrops, these melts have migrated along the foliation and coalesced to give the whole rock a remobilized, migmatitic appearance. Scintillometer values are erratic over this unit, with bimodal concentrations at 40-50 cps and 130-150 cps.

Two outcrops of pink, medium grained, equigranular, biotite granite (5) were examined in the central part of the unit 4 biotite granite south of the Red Wine River. It may be related to unit 4, but no contacts were seen. Scintillometer readings were between 150-180 cps at each locality.

Three outcrops of variably foliated gray to white weathering, medium grained garnetiferous leucodiorite (6) were observed in the vicinity of the Red Wine River. The rock consists of scattered porphyritic melanocratic inclusions several tens of centimetres in maximum size in a medium grained leucocratic matrix, both cut by very fine grained leucocratic dikes. The mineralogy in all three phases is plagioclase, hornblende and garnet. Only mineral proportions and grain size distinguish between the three varieties. One pervasive foliation is present in this lithology, which, when strongly developed, gives it a gneissic appearance as a result of the elongation of inclusions and flattening of the dike network parallel to the foliation.

Large parts of the area are underlain by medium to fine grained, white to pink weathering leucogranite, granodiorite and aplite (7). These are characteristically equigranular, sugary rocks which vary from nonfoliated to gneissic. Biotite is the main foliation-forming mineral, but muscovite is present locally, as are stubby hornblende grains and small red garnets. The fine grained saccharoidal character of these rocks in the Mount Elizabeth - Nipishish Lake area led Stevenson (1967) and Williams (1970) to interpret them as metasedimentary. However, no indications of a sedimentary origin were observed. The presence of inclusions of granite and gneiss like those described above indicates an intrusive origin, as documented by Fahrig (1959) and Ryan and Harris (1978).

Not all the rocks included within this group are identical. The microgranites in the vicinity of Crooked River and west of Nipishish Lake are generally medium to very fine grained pink saccharoidal rocks which are massive to gneissose. White quartz veins, sometimes having an *en echelon* pattern, are present locally; these may be up to 2 m thick and several tens of metres in strike length. Where the granite is deformed, these veins are mylonitic and weakly banded, possibly explaining why Stevenson interpreted them as metaquartzites and meta-arkoses. Background radioactivity values in this fine grained pink granite are consistently higher on the average than the surrounding rocks. Measured values ranged between 80 and 450 cps, with most above 130 cps. The 450 value was recorded from an area south of Mount Elizabeth corresponding to a uranium anomaly detected during the 1977 URP regional survey (McConnell, 1979).

Along the southwest shore of the Naskaupi River, the microgranites are brown to pink weathering, and locally garnetiferous and gneissose. One outcrop of coarser grained, granular, white weathering granite with stubby hornblende prisms was noted within this unit. Radioactivity registered 90-180 cps.

Whitecock Head and surrounding area is composed of medium grained, massive to schistose, sugary, biotite-bearing granodiorite. Rafts of banded amphibolite were noted in one exposure. Scintillometer readings of radioactivity measured at four localities in this unit ranged between 90 and 150 cps.

Two outcrops of undeformed, fine to medium grained, pale green weathering, leucodiorite (8) were observed at the southwest margin of the area.

Anorthosite (9)

Coarse grained anorthosite and leucogabbro were briefly examined in the vicinity of Mount Sawyer. These rocks are gray weathering, with plagioclase laths up to several centimetres long.

Pyroxene and ilmenite (?) are the main intercumulus phases. A prominent hill south of the confluence of the Red Wine and Naskaupi Rivers is composed of anorthosite and ultramafic cumulates (9a). A border zone of well layered (cm to m scale), chromite-bearing, rusty to gray weathering, ultramafic and anorthositic rocks is particularly well exposed along the northeast side of the hill; Stevenson (1967) called these banded rocks meta-andesites. The layering in the ultramafics is persistent along strike for tens of metres, and is folded into megascopic folds at the southeast end of the small ridge on which these rocks outcrop. The anorthositic rocks are intrusive into the ultramafic portion, a discordant relationship between banding in the ultramafics and a sill of anorthosite being observed at the top of the hill.

The relationship of the anorthositic rocks to the surrounding granitoids was not established, but Stevenson (1967) noted an intrusive contact at which the basic rock "apparently intrudes the gneisses". Radioactivity is low, values of 40-60 cps having been recorded.

Seal Lake Group (10)

Regional geological maps by Fahrig (1959) and Stevenson (1967) show Seal Lake Group sediments extending south of the Naskaupi River almost to the Red Wine River and, thence, eastwards through Mount Elizabeth and the Crooked River. This survey has shown that there is no basis for the outcrop distribution of Seal Lake Group "metaquartzites" shown on Stevenson's (1967) map, and that some of the rocks adjacent to the Naskaupi River shown as Seal Lake Group on Fahrig's (1959) map are strongly schistose granite, locally having an augen texture and misinterpreted by Cote (1970) as conglomerate.

The southern part of the Seal Lake Group in the study area is composed of white and gray, sugary and sericitic, metaquartzite, grit, and quartz pebble conglomerate units (10) with intercalated schistose chloritic metabasic volcanics (10a), all belonging to the Bessie Lake Formation of Brummer and Mann (1961). No facing directions could be obtained from outcrops of sediments visited. Background radioactivity of the sediments is low, averaging 80 cps, but observed values range between 40 to 100 cps.

Michael Gabbro(11)

Dikes of black, medium grained, Michael Gabbro (Fahrig and Larochelle, 1972) outcrop in the vicinity of Crooked River. These dikes are part of an extensive podiform series which continues eastwards to the Labrador coast (see Gower, this volume).

DISCUSSION

A brief reconnaissance survey of part of the Grenville Province north of Grand Lake has indicated that the area is dominated by a gneiss-granite-anorthosite assemblage which apparently predates the Seal Lake Group. An unconformity is postulated to be present along the eastern margin of the group, but along the southern boundary the contact is tectonic, with the older granites thrust northwards over the basal Seal Lake Group sediments. This thrust appears to continue southeastwards along the valley of the Naskaupi River.

The above considerations indicate that much of the area now considered to be underlain by Grenvillian gneisses is, in fact, composed of rocks of pre-Neohelikian age which may range in age from Archean to late Paleohelikian. The effects of Grenvillian deformation have not been satisfactorily determined. For instance, the generally north-trending attitude of the foliation in the pre-Seal Lake Group rocks seems to be a pre-Grenvillian feature although similar trends were locally encountered within the Seal Lake Group. Foliations with an east to southeast trend are related to Grenvillian thrusts and shears in the rocks along the Naskaupi River. Subhorizontal foliation measured in the gneissic terrain east of Crooked River may be an early feature in these rocks or it may reflect unrecognized thrusts or nappes of Grenvillian age in the area.

The major thrust which juxtaposes granites and Seal Lake Group quartzites near the Seal Islands is offset along a fault which is assumed to occur west of Mount Sawyer. This fault is the southerly extension of the Pocketknife Lake Fault zone, the reactivated boundary between the Nain and Churchill Structural Provinces.

In summary, there seems little chance of finding metamorphosed Seal Lake Group lithologies in the region south of Nipishish Lake and Naskaupi River, the rocks there being apparently of pre-Seal Lake Group age. No metavolcanic rocks of Bruce River Group type were observed anywhere in the study area.

Economically, the microgranite of the Mount Elizabeth area may be worthwhile for further uranium exploration.

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GEOLOGY OF THE DOUBLE MER - LAKE MELVILLE AREA, LABRADOR

by

D.G. Bailey

INTRODUCTION

The area described in this report is located about 100 km northeast of Goose Bay, Labrador, and is part of an isthmus separating Double Mer from Lake Melville. The nearest community is Rigolet, about 50 km to the east-northeast of the area mapped. The area is accessible from Goose Bay by float plane and boat.

The region was first mapped by Stevenson (1970) and Eade (1962) as part of the Geological Survey of Canada regional mapping programs. In 1977 the area was included in a regional geochemical lake sediment sampling program and some lake sediment samples were found to be anomalously high in uranium. Follow-up work by the Mineral Development Division (McConnell, 1979) determined the presence of uranium mineralization at three localities. Because the area contains the only significant uranium showings discovered to date in the eastern Grenville Province of Labrador, it was decided to map the area immediately.

Regional Geology

The Double Mer - Lake Melville area is underlain by rocks of the Grenville Province, a region of the Canadian Shield defined by 1,000 Ma K/Ar dates and easterly structural trends. The northern part of the Grenville Province of eastern Labrador is marked by east-west shear zones (Stevenson, 1970; Bailey *et al.*, 1979) which parallel a large granitic batholith comprising the Benedict Mountains. South of the Benedict Mountains, Stevenson (1970) has mapped a zone of paragneiss, although there is some suggestion that this zone may consist mainly of highly deformed granite (Bailey *et al.*, 1979; Gower, personal communication, 1979). Metamorphic grade is generally middle to upper amphibolite facies (Bourne, 1978) but just to the north of Double Mer, granulite facies rocks occur (Stevenson, 1970).

Stevenson (1970) has mapped granitic gneiss of possible Helikian age south of Double Mer and in the area described in this report. A large anorthosite massif, described by Emslie (1976), and undefined gneisses and highly deformed granitic rocks occur south of Lake Melville.

Sandstones and shales of the Double Mer Formation are preserved in down-faulted blocks on the north and south sides of Double Mer, and south of Lake Melville in the vicinity of Goose Bay. The age of the formation is not known, although it is younger than the Grenville Orogeny. Stevenson (1970) considered that these rocks may be of Cambrian age since they are similar to Cambrian strata in the southeastern part of Labrador. On the other hand, they may also be of similar age to the Siamarnekh sandstones of possible Hadrynian age in northern Labrador and Quebec.

GEOLOGY OF THE DOUBLE MER - LAKE MELVILLE AREA

The map area is underlain by gneisses, migmatites and granitic rocks which, for the most part, are strongly deformed. Gneisses are subdivided on the accompanying map on the basis of composition as seen on outcrop scale. Since no petrography has yet been carried out on these rocks, complete metamorphic mineral assemblages have not been determined.

Unit 1

This unit consists of well banded gneiss in which the leucosome is dominant over the melanosome. The leucosome comprises white and gray bands of granitic composition, up to one metre wide; the dark bands are of amphibolitic composition. The unit is subdivided on the basis of the composition of melanosome bands. Unit 1A has amphibolite containing dark red porphyroblasts of garnet, in some places reaching a size of about 10 cm diameter. Unit 1B is apparently devoid of garnets, at least on the hand specimen scale.

Unit 1A is in gradational contact with Unit 2. Contacts of Unit 1B with other units were not seen, but since adjacent rocks are considered to be younger, a fault contact is postulated between Unit 1B and Unit 8.

Unit 2

This unit is composed of dominantly amphibolitic material towards its upper contact, although its lower part is similar in composition to Unit 1. It is well banded with individual bands ranging from a 10 cm to several metres in width. The leucosome is of granitic composition. The contact of Unit 2 with Unit 3 varies from sharp to gradational over several metres.

Unit 3

Unit 3 is a highly distinctive rock, comprising a very well foliated and somewhat banded prophyroblastic gneiss. Individual porphyroblasts range up to several centimetres in diameter and generally consist of white potassium feldspar. The matrix of the porphyroblastic gneiss is granitic, although in places there is an abundance of dark minerals. Banded parts of the unit consist of porphyroblastic gneiss and amphibolite.

Unit 4

Unit 4 is generally similar to Units 2 and 6A. It has an intermediate to mafic composition, with a granitic leucosome. Generally the granitic part of the gneiss is the older; the more mafic part consists of amphibolite which probably represents mafic dikes intruded into a dominantly granitic terrain. The unit is in sharp contact with Unit 3 but in gradational contact with the structurally overlying gneiss (Unit 5).

Unit 5

This unit is a transitional lithology between Unit 4 and Unit 6. It is dintinguished from adjacent units by a greater amount of granitic material, and also has concordant bands of well foliated leucogranite.

Unit 6

In places this unit is very complex and is difficult to characterize. It is subdivided into two distinct rock types; 6A, which consists of well banded amphibolitic gneiss; and 6B, which is a poorly banded to nonbanded migmatite of dominantly granitic composition in which dark green and gray mafic bands and lenses are common. The subunits are sufficiently distinctive to be separated, but because 6A and 6B appear to occupy the same structural level, they are grouped into the same unit.

Unit 7

This unit is strongly deformed and comprises several rock types. The dominant lithology is fine grained pink to gray granite and granodiorite. In some outcrops the granite is leucocratic; in other outcrops there is an abundance of hornblende. Bright pink foliated granite is also common in addition to the pink granodiorite.

LEGEND

HADRYNIAN (?)

11 DOUBLE MER FORMATION: Red and brown arkosic sandstone and shale.

HELIKIAN (?)

10 White, gray, locally pink, coarse grained leucogranite. Occurs as irregular bodies and dikes.

APHEBIAN-HELIKIAN (?)

9 Medium to fine grained amphibolite.

8 A. Medium grained, pink equigranular hornblende granite and granodiorite, strongly foliated.

B. Coarse grained, strongly foliated and augened hornblende-biotite granite and granodiorite, minor biotite-hornblende granodiorite.

C. Medium to coarse grained strongly foliated biotite granite with abundant mafic bands and lenses.

7 Gray to pink, fine to medium grained, well foliated hornblende granite and leucogranite; contains large amount of mafic and intermediate material as bands and lenses; migmatitic and schlieric in places.

ARCHEAN-APHEBIAN (?)

6 A. Well-banded amphibolite gneiss; melanosome greater than leucosome.
B. Granite gneiss and migmatite; leucosome greater than melanosome.

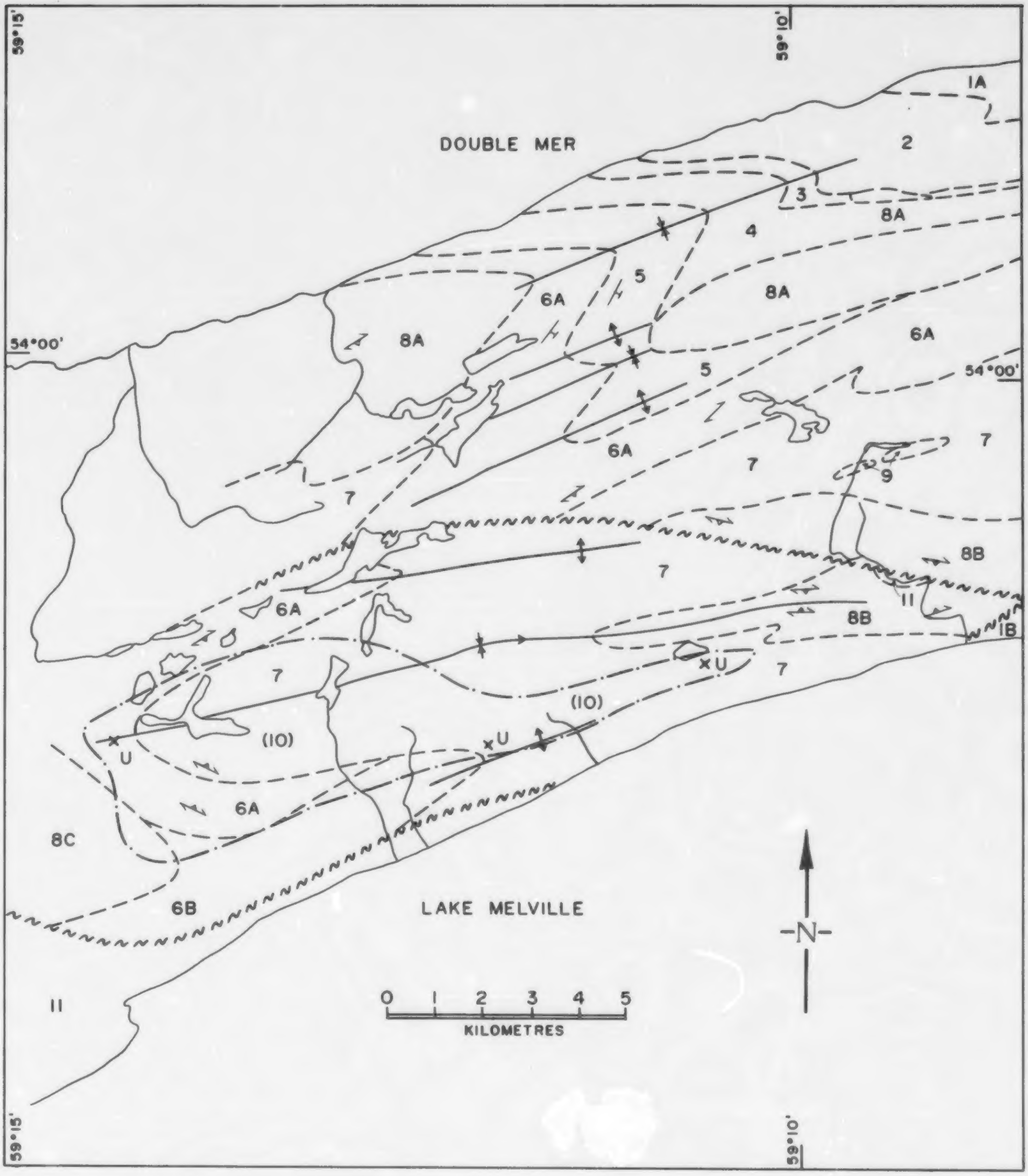
5 Well-banded gray granitic gneiss and leucogranite.

4 Well-banded intermediate to mafic gneiss; granitic leucosome.

3 Gray, porphyroblastic granitic gneiss.

2 Dark gray and green banded amphibolite gneiss.

1 A. Gray to buff granitic gneiss; garnetiferous amphibolitic paleosome.
B. Gray to buff granitic gneiss; non-garnetiferous paleosome.


59°15'
59°10'
54°00'
DOUBLE MER
LAKE MELVILLE
1A
2
3
4
5
6A
6B
7
8A
8B
8C
9
(10)
11
1B
U
-N-
0 1 2 3 4 5
KILOMETRES

Geological Map of Double Mer — Lake Melville Area (13G/14, 13J/3), Labrador.

These pink rocks are generally of coarser grain size than the pink and gray fine grained granite.

A variety of rock types which are mainly of mafic composition and contain abundant hornblende and biotite occur within the granites. They may have been part of an older igneous terrain into which the granitic rocks were intruded.

Unit 8

Unit 8, which is subdivided on the basis of texture and composition, is generally strongly foliated and of granitic to granodioritic composition. Unit 8A comprises a pink well foliated biotite and hornblende granodiorite with minor pink granitic phases. These rocks are generally medium to fine grained. Mafic bands and xenoliths, now transposed into the plane of foliation are common throughout the unit.

Unit 8B is a very distinctive, augened, coarse grained granodiorite with large megacrysts of potassium feldspar. These megacrysts are now ovoid and may be porphyroblastic in origin. Numerous amphibolite dikes, deformed and transposed into the foliation, occur throughout the unit. Some minor amounts of more granitic, less foliated rocks occur within the augen granodiorite.

Unit 8C comprises a coarse grained, gray, biotite-rich granite to granodiorite. Mafic nebulitic bands and streaks within the granite may be partially assimilated mafic rock into which the granite was intruded.

Unit 9

Numerous mafic dikes and lenses occur throughout the area and are clearly pretectonic. They are generally diabasic although the original diabasic texture has been destroyed by deformation in most cases. The dikes occur parallel to the regional foliation direction, and, in areas of poor exposure, are difficult to dintinguish from the older mafic bands within granitic rocks.

Unit 10

Numerous dikes, veins and irregular masses of generally coarse grained leucogranite intrude all other rock types with the exception of the Double Mer Formation. The area containing the greatest concentration of this rock type is represented on the accompanying map by a dashed and dotted line although it is impossible to map out individual bodies at the scale of mapping. In places this leucogranite has intruded concordantly along the banding and foliation of the older rocks, giving the appearance of a migmatite. The unit is important as it is associated with uranium mineralization in the area.

Unit 11

Sandstones and shales of the Double Mer Formation (Kindle, 1924) are preserved in the eastern part of the map area within a half graben produced by downfaulting. Near the fault contact, the sandstones are coarse grained and exhibit good crossbedding, but they pass upwards into more shaly members containing intercalated sandstone beds. Although not seen in the map area, conglomeratic beds occur towards the base of the formation north of Double Mer.

The writer considers that these sediments once covered the whole of the map area but have subsequently been removed by erosion. On the north side of the area, sandstone is preserved as infillings in cracks in the basement rocks.

STRUCTURE

The rocks throughout the map area, with the exception of Units 10 and 11, are generally strongly deformed with easterly and northeasterly trending foliation and gneissosity. Both gneissosity and foliatin are folded into antiforms and synforms indicating at least two periods of deformation in the area. Foliation in many places is warped into a strain-slip or crenulation fabric at roughly 30° to the main fabric direction, *i.e.* in a northeasterly direction.

The gneisses which are structurally lower in the sequence have been affected by multiple deformation, in contrast with the single fabric development seen throughout most of the structurally higher rocks. This would suggest the presence of a break between the two groups (*i.e.* units 1 to 6 and units 7 to 9) which has probably been obliterated by structural reworking.

On the map scale two major folds occur in the area. A large east-plunging synform occurs south of the east-west fault which runs through the middle of the map area; an antiform occurs north of the fault and plunges to the west. This pattern would indicate that scissor - type movement has occurred on the fault, but in general with the northern block upthrown with respect to the southern block.

On the northern coast of the area, abundant shearing is present with individual shears striking at about 080°. Along shear zones, biotite has retrogressed to chlorite and secondary hematite and epidote have developed. Shears generally dip to the south, although northerly dips have been recorded.

METAMORPHISM

The grade of metamorphism is probably of the middle amphibolite facies. Typical metamorphic assemblages consist of biotite-hornblende plagioclase-garnet. In zones of retrogression the chlorite-epidote-hematite assemblage has developed from biotite and hornblende. In some rocks it seems that biotite has developed from the break down of hornblende.

Metamorphic minerals considered to be diagnostic of sedimentary protoliths have not been recognized in the region. However, since no thin sections have been studied, this cannot be verified; some older rocks in Unit 7 have compositions which may be similar to that of graywacke.

AGE OF THE ROCK UNITS

In the absence of any units of known age, attempts to place the rock units into a Precambrian stratigraphic framework are tenuous. Relative ages of rocks can be assessed by the number of deformational events to which they have been subjected, but whether these events occurred during the same orogeny or during different orogenies is not known.

The rock units have been grouped according to the number and intensities of deformation. The youngest granitoid rock (Unit 10) has undergone almost no deformation, an intermediate group of granitic rocks has only one dominant fabric, and the oldest group has undergone several deformations. In addition, the oldest group has rocks in which a strong gneissosity has developed, whereas younger rocks, although having a well developed foliation, have no compositional banding attributable to metamorphism.

On that basis, deformation of Units 1 to 6 is considered to have occurred during an earlier orogeny than the deformation of Units 7 to 9. The time of deformation, however, is not known and can only be inferred. If Unit 10 was intruded during the Helikian era, it can be concluded that effects of Grenvillian deformation in the map area are minimal. If this is the case, then the Grenvillian Orogeny is manifested in the area only by a metamorphic retrogression. However, shearing along the northern side of the map area may be Grenville in age as it is clearly later than deformational fabrics of the gneisses.

If the granite of Unit 10 is post-Grenville in age, *i.e.* Hadrynian, then it is possible that rocks of Units 1 to 6 are of Aphebian or Archean age and rocks of Units 7 to 9 are of Helikian age, and were deformed during the Grenville Orogeny. Definition of the ages of the various rock types must await radiometric dating.

URANIUM MINERALIZATION

Uranium occurs in three known showings within the zone in which there is a dominance of Unit 10 granite. Rocks in this area have zones of above normal background radioactivity (up to 500 cps compared to about 150-200 cps outside the area, measured as total counts on a G1S-4 spectrometer).

The primary uranium mineral has not been identified, but showings typically have yellow uranophane (?) coatings on exposed surfaces. Uranium occurs both as patches within the leucogranite of Unit 10 and at the contacts of the granite with older, more mafic rock. In the latter case, uranium mineralization is commonly concentrated in chloritic partings parallel to the foliation of the older rocks.

Minor molybdenite is associated with uranium in a radioactive boulder found in the westernmost showing; minor fluorite has also been recognized. At the central showing large black cyrstals of tourmaline are also present. Magnetite appears to occur in high concentrations with some mineralization while hematite is also associated with the uranium.

The high U/Th ratios of the uranium showings suggest that mineralization was concentrated by hydrothermal solutions, but extensive zones of hydrothermal alteration do not seem to have developed.

Because of the rather large extent of Unit 10 there may be considerable potential for the discovery of further areas of uranium mineralization, although detailed prospecting will be required in areas of poor outcrop.

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GEOLOGY OF THE ADLAVIK ISLANDS

by

Allan Doherty

INTRODUCTION

This report summarizes geological mapping undertaken during a six week period in the Adlavik Islands on coastal Labrador south of Cape Makkovik. The map area is covered under topographic map sheets 13J/15 and 13O/2, (N.T.S. 1:50,000) and is an eastern extension of field mapping completed in 1978 as reported by Bailey *et al.* (1979).

Previous reconnaissance mapping in the Adlavik Islands was done by Kranck (1953) and Stevenson (1970). The object of the present mapping project was to determine the distribution of Aillik Group volcanics and granitic intrusive rocks and to assess the mineral potential of the area.

GENERAL GEOLOGY

The map area is underlain by the Aillik Group, an Aphebian supercrustal sequence of volcanics and sediments intruded by a complex of synkinematic to postkinematic felsic to intermediate plutonic rocks. Aillik Group volcanics were mapped on some of the more northern islands within the map area but are generally absent or occur only as enclaves within the granitic rocks in the south. Outcrop distribution within the area is limited to approximately 15% of the total area but is fresh and free of lichen and vegetation. Large intervening expanses of sea result in correlation difficulties from island to island.

Stratigraphy

The Aillik Group as described by Bailey *et al.* (1979) consists of basal pelitic semi-schist and lower mafic pillow lavas, a middle sequence of mixed felsic volcanics and epiclastic derivatives and an upper sequence of mafic pillow lavas, tuff, rhyolite ash flow, ash flow tuff, and hypabyssal rhyolite. Generally within the map area only the middle part of the Aillik Group was encountered. In addition the stratigraphic succession is uncertain due to the limited nature of the outcrop.

Felsic conglomerate and breccia (Unit 1)

This unit outcrops on Gull Rocks and is a continuation of units outcropping along strike on Pomiadluk Point. It is from 50 to 100 metres thick and contains large pebbles to cobbles of felsic volcanics and granite in a fine grained, dark gray, psammitic matrix containing abundant sheared lenticular epidote and chlorite streaks. The granitic clasts have an internal fabric and are more abundant towards the base of the section, grading upwards into smaller more elongate and sub angular felsic volcanic clasts toward the top of the section. Minor, mafic tuff horizons, one metre thick, occur above the coarse granite clast bearing horizon. This unit is gradatinal into the overlying felsic tuff and arkose unit.

Felsic tuff and arkose (Unit 2)

These rocks are commonly highly felspathized and the distinction between felsic tuff and arkose is equivocal. Generally where the rocks lack any well developed sedimentary structures and contain prophyroblasts of K-feldspar and quartz, they have been mapped as felsic tuff. Near contacts with granite intrusions, the degree of felspathization is so extreme as to preclude any reasonable differentiation between sediments and volcanics in outcrop; the rocks may be in part intrusive.

LEGEND

HELIKIAN

7 Complex migmatite - gray banded gneiss paleosome, medium grained granitic neosomeL

6 Syenite, syenodiorite - massive coarse grained and cummulate banded syenite.

5 Granite, granitic gneiss in part(?); Quartz monzonite; coarse grained gray granodiorite; pink porphyritic granite: includes both syntectonic and post tectonic granites.

APHEBIAN

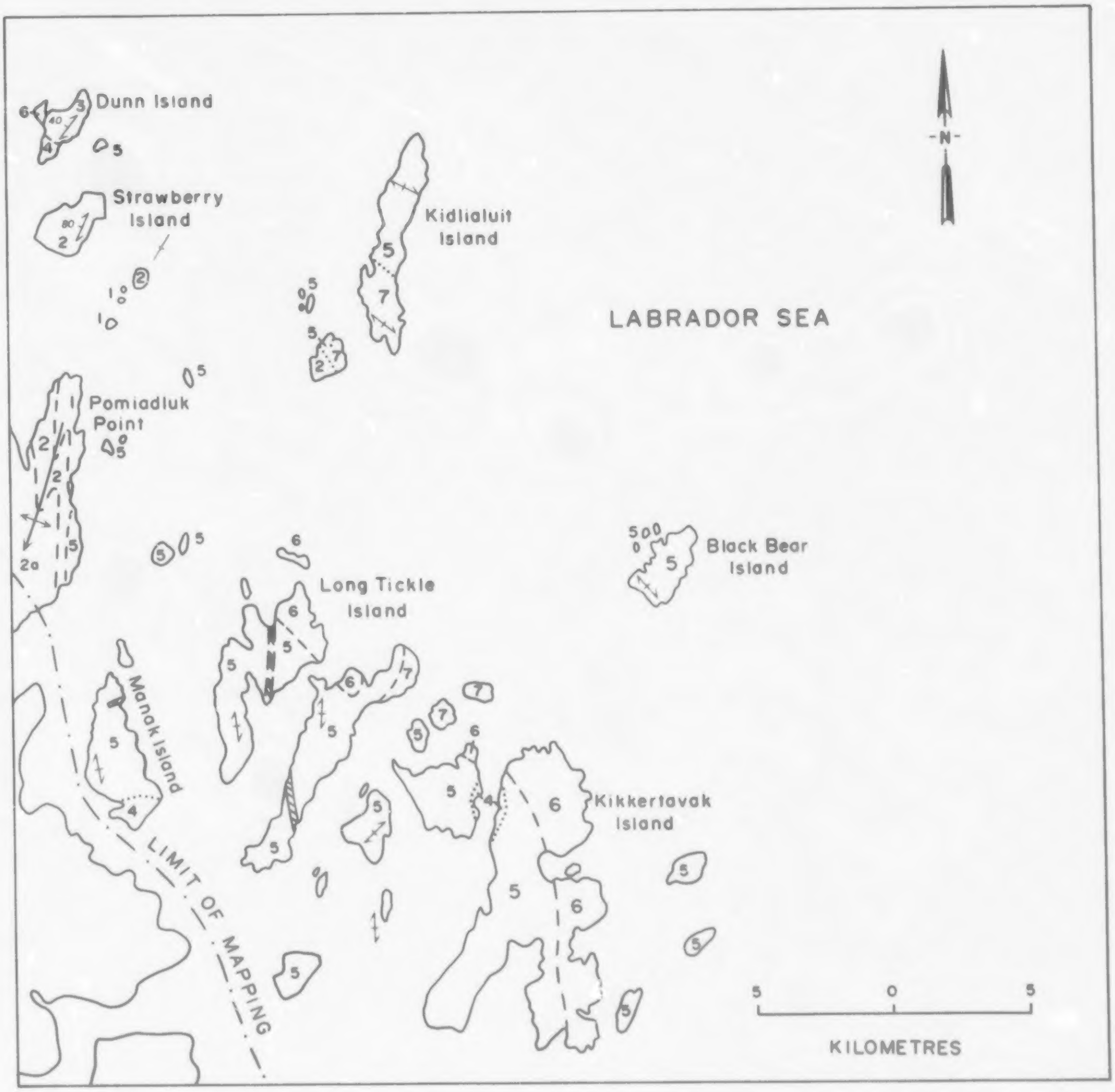
AILLIK GROUP

4 Mafic volcanics, mafic flow and flow breccia

3 Tuffaceous sediments, pink, red and green tuffaceous sediments, minor volcanic conglomerate.

2 Felsic tuff, crystal tuff, minor arkose, banded psammite; 2a, arkose sandstone

1 Felsic conglomerate and breccia, polylithologic volcanic conglomerate, minor mafic tuff.


Dunn Island
Strawberry Island
Kidlialuit Island
N
LABRADOR SEA
Pomiadluk Point
Black Bear Island
Long Tickle Island
Manak Island
Kikkertavak Island
LIMIT OF MAPPING
5 0 5
KILOMETRES

The felsic tuff is a very light weathering saccaroidal rock with numerous 1-5 mm porphyroblasts of pink K-feldspar and quartz. It contains somewhat discontinuous bands and streaks of mafic minerals and alteration veinlets of chlorite. Specular hematite and calcite are common and are frequently associated with higher radiometric values. Some minor discontinuous lenses of gray and black banded psammite are interbedded with the felsic tuff on Belle Island off Pomiadluk Point where the best exposures of this unit outcrop. To the north on Strawberry Island, the felsic tuff is more massive and has a somewhat igneous texture due to a greater degree of felspathization.

Tuffaceous sediments (Unit 3)

Well bedded and crossbedded pink, gray and green tuffaceous sediments outcrop on the east side of Dunn Island. Lenses of volcanic conglomerate containing subangular to rounded clasts of chert and felsic volcanics in an epidote-rich matrix are contained within the sediments. Over large areas on Dunn Island, numerous mafic dikes and aplite veins have crosscut the sediments and, with strong felspathization, has resulted in a rock type with characteristics of a migmatite.

Mafic volcanics (Unit 4)

Highly sheared mafic volcanics and volcanic breccia with pervasive epidote and potassic feldspar alteration outcrop on Manak Island and Kikkertavik Island. The outcrops are surrounded by granite and quartz monzonite and may be large enclaves.

Intrusive Rocks

Intrusive rocks vary from minor pyroxenite to syenite, quartz monzonite and granite. The marginal zones of most plutons host many mafic dikes and Aillik Group volcanic xenoliths. In addition very strong inhomogeneous deformation and gradational contacts between most phases cause difficulty in defining mappable units. No staining or thin sectioning has been done and the following brief descriptions are based on field observation only.

Granite-Quartz Monzonite (Unit 5)

The greater part of the map area is underlain by homogeneous granite to quartz monzonite intrusions. The texture varies from medium grained equigranular to coarsely porphyritic. The quartz content varies from approximately 5% to 30%. More massive pink prophyritic granites in the northern part of the map area closely resemble the Strawberry granite described by Kranck (1953), and are most probably posttectonic granites. However, they have not been included as a separate unit on the accompanying map.

Toward the margins of the intrusions, numerous xenoliths of mafic dike rocks, Aillik Group volcanics and gabbro with well developed cumulate banding are found chaoticaly distributed within the grainte and quartz monzonite. The marginal areas also show strong heterogeneous deformation with well developed mineral foliations. Late stage pegmatite and aplite veins are common throughout the granite and quartz monzonite.

Syenite (Unit 6)

Massive nonfoliated syenite to syeno-diorite intrusions displaying well developed cumulate banding borders the granite and quartz monzonite of Unit 5. Age relations are uncertain but the absence of foliations suggest that it postdates the granite and quartz monzonite although it may be a late phase of the same magmatic event.

Migmatite (Unit 7)

On Kidlialuit Island there are exposures of complex migmatite generally displaying an agmatitic texture. The paleosome is a gray, banded quartzo-feldspathic gneiss invaded by a medium grained leucogranite neosome. Age relations are uncertain; the gneissic paleosome was not encounterd elsewhere in the map area and contact relations are ambiguous.

Dike rocks

At least three phases of mafic dike injection are present in the plutonic rocks, with an early disrupted and boudinaged phase, and two later phases showing crosscutting relations. Dark brown weathering, carbonate rich, lamprophyre dikes are also present. The dike rocks have not been included on the accompanying map.

STRUCTURAL GEOLOGY

The Aillik Group volcanics in the northern part of the map area host a strong northeast trending penetrative axial planar fabric which dips steeply to the northwest; no earlier fabrics were noted.

Igneous intrusions in the south generally show a weak to moderate north-south Hudsonian fabric with localized late east-west trending Grenville shears.

ECONOMIC GEOLOGY

Primary exploration potential within the map area is for uranium deposits in the Aillik Group volcanics. Normal background over the felsic volcanics is in the order of 400 cps. A number of areas registered up to four times background. Generally, areas with chlorite-hematite alteration veinlets yield the highest anomalies.

Other radiometric anomalies are associated with allanite-bearing pegmatite veins within the granitic rocks. One small anomaly (7,000 cps) occurs over approximately 30 m x 1 m within a pyrite-bearing quartz-muscovite vein near the migmatite-granite contact on Kidlialuit Island.

Minor pyrite-pyrrhotite and molybdenite mineralization was noted but generally only a few minor flecks of molybdenite were seen.

ACKNOWLEDGEMENTS

Able field assistance and boat work was supplied cheerfully by Bill Collins. Field discussion with Dr. Dave Bailey during a one day tour of the area was greatly appreciated. The logistic support of Wayne Tuttle and crew in Goose Bay helped greatly throughout the summer.

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GEOLOGY OF THE SOUTHWESTERN MARGIN OF THE CENTRAL MINERAL BELT

by

A. Thomas and D. Hibbs*

INTRODUCTION

Mapping at a 1:50,000 scale of the rocks bordering the southwestern part of the Central Mineral Belt was begun in 1978 and covered the southeast part of N.T.S. sheet 13L/2 and parts of sheets 13L/1 and 13L/8. During 1979, mapping was extended eastwards to cover all of N.T.S. sheets 13L/1 and 13K/4, an area bounded by longitudes 61°30'W to 62°30'W and latitudes 54°00'N to 54°15'N.

Rocks of the Seal Lake Group have been mapped at reconnaissance scale (Fahrig, 1959; Brummer and Mann, 1961; Roscoe and Emslie, 1973) and at a more detailed scale by Frobisher Ltd., Brinex and Cominco. Marten (1975) has worked locally around Letitia Lake. The gneiss terrain south of Red Wine Lake is included in the regional maps of Geiger (1961) and Stevenson (1969).

Rocks south of the Red Wine River have been mapped in more detail by Emslie *et al.* (1978). The most recent comprehensive study of the Red Wine alkaline complex has been done by Curtis and Currie (in press).

GENERAL GEOLOGY

The central part of the map area is underlain by a basement terrain consisting of Aphebian or Archean Wapustan gneiss intruded by late Aphebian or early Helikian granitic and dioritic rocks of the North Pole Brook complex. In the southern part of the area, this basement terrain is in fault contact with the Disappointment and Hope gneisses which represent for the most part probable older basement reworked during the Grenville Orogeny.

Rocks of Paleohelikian age in the area include the Letitia Lake and Arc Lake Groups, Red Wine alkaline complex and several bodies of gabbro and diabase. The Letitia Lake Group consists principally of felsic volcanic rocks and porphyries which both overlie and intrude basement granite. The Letitia Lake Group is intruded by rocks of the Arc Lake group which consist of alkali syenite, alkali granite and associated porphyries. Metamorphosed agpaitic plutonic rocks of the Red Wine complex are minor in the area and occur in association with Arc Lake group syenites. The gabbro and diabase bodies intrude Disappointment gneiss, (where they have been metamorphosed to amphibolite) and granite of the North Pole Brook complex.

Conglomerate, quartzite, siltstone and argillite interbedded with mafic flows and gabbro sills comprise the lower part of the Neohelikian Seal Lake Group. These rocks rest unconformably upon Letitia Lake Group rocks and basement granite in the northern part of the area.

The entire map area lies within the Grenville Front tectonic zone. It is cut by mainly east-west trending faults of Grenvillian age and exhibits Grenvillian metamorphic effects and fabric overprints.

Hope gneiss (Unit 1)

Rocks of the Hope gneiss are confined to the Red Wine mountains

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LEGEND

NEOHELIKIAN

Seal Lake Group

9a Bessie Lake Formation: Amygdaloidal to massive green basalt flows interbedded with feldspathic to clean, gritty coarse white quartzite (base of unit characterized by porphyry cobble conglomerate and hematite-magnetite shale and wacke derived from unit 6).

9b Wuchusk Lake Formation: Gabbro sills, diabase dikes and sills, siltstone, shale, argillite and interbedded chert.

PALEOHELIKIAN

8 Red Wine alkaline complex: 8a, Green pyroxenic-aenigmatitic gneiss; 8b, blue-black omphacitic-nephelinic gneiss; 8c, leucocratic medium grained arfvedsonite-feldspar gneiss with minor nepheline, pyroxene and eudialyte; 8d, malignite and nepheline syenite.

7 Arc Lake group: 7a, Dark to pink green mafic alkali syenite; 7b, gray, intermediate alkali, quartz syenite; 7c, felsic alkali quartz syenite and alkali quartz-feldspar porphyry; 7d, alkali granite.

6 Letitia Lake Group: 6a, Massive intermediate to felsic feldspar porphyry and quartz-feldspar porphyry; 6b, felsic volcanics including porphyritic rhyolite, banded rhyolite, crystal tuff and ignimbritic tuff; 6c, regolith of oxidized felsic volcanics, oxidized and hematized quartz-feldspar porphyry, magnetitic grit, muscovite-sericite schist.

5 Gabbro, diabase.

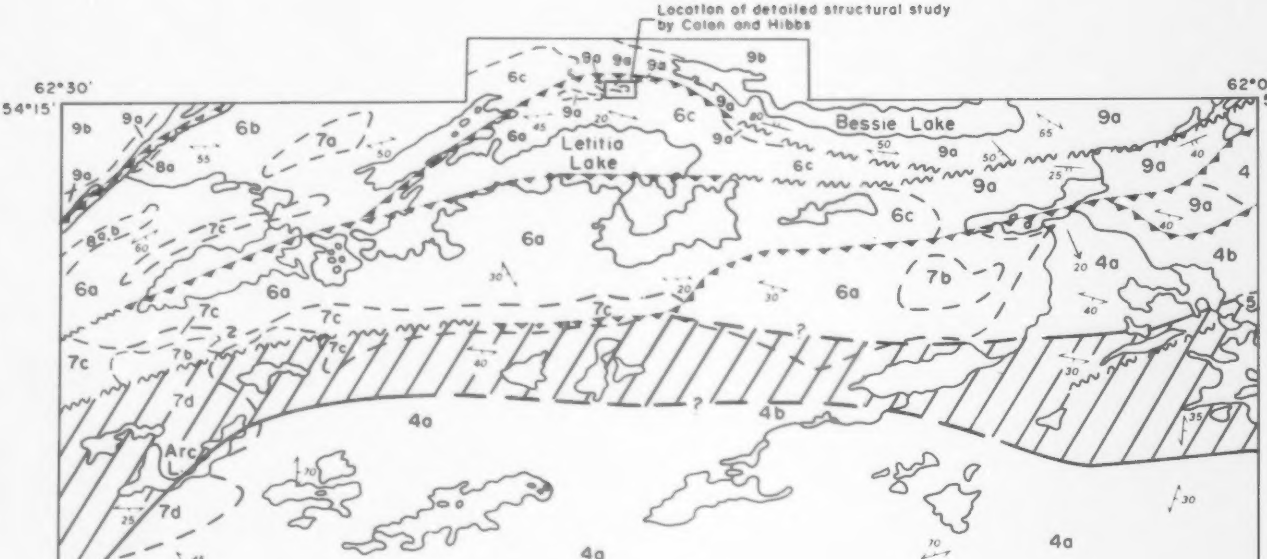
4 North Pole Brook complex: 4a, Equigranular hornblende-biotite granite; 4b, porphyritic hornblende-biotite granite; 4c, equigranular biotite granite; 4d, porphyritic biotite granite; 4e, monzodiorite, quartz monzonite.

APHEBIAN-ARCHEAN

3 Wapustan Gneiss: Siliceous, quartz-feldspar-muscovite-biotite, minor sillimanite paragneiss cut by mafic dikes, now metamorphosed and boudinaged into massive to banded amphibolite pods. Gneiss is highly contorted and commonly contains disseminated pyrite and pyrrhotite mineralization. Gneiss also contains large bodies of massive to banded greenstone composed of hornblende, quartz and chlorite.

2 Disappointment Gneiss: Granodioritic hornblende-biotite-muscovite-sillimanite-feldspar-quartz gneiss cut by mafic dikes, now boudinaged and metamorphosed into massive to banded amphibolite pods.

1 Hope Gneiss: Hypersthene-biotite-garnet-sillimanite-feldspar-quartz gneiss.


Location of detailed structural study by Colan and Hibbs
62°30'
54°15'
62°00'
54°15'
Bessie Lake
Letitia Lake
Arc L.
Red Wine River
Red Wine Lake
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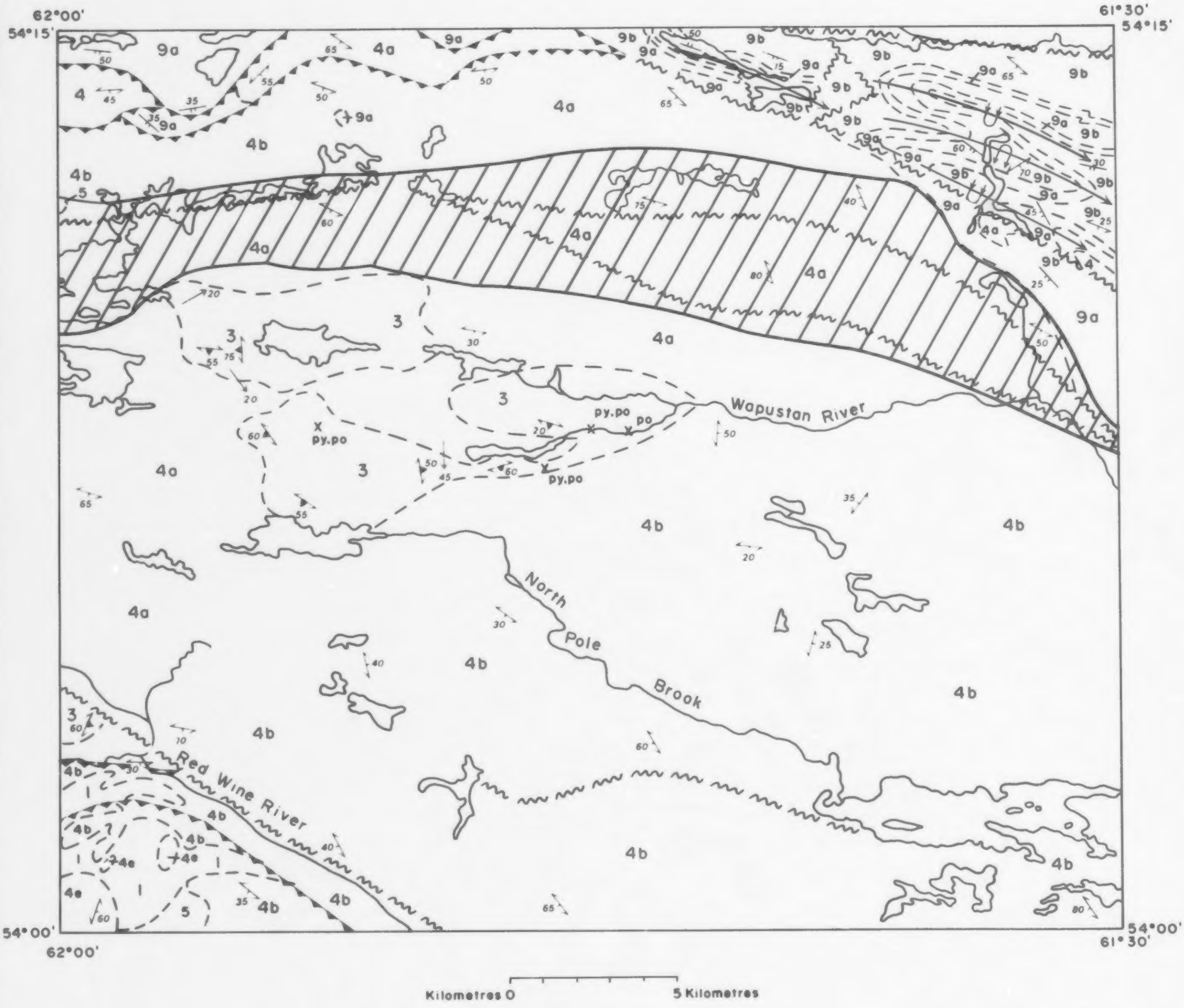
62°00'
Kilometres 0
5 Kilometres

LETITIA LAKE 13L/1


62°00'
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Wapustan River
North Pole Brook
Red Wine River
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5 Kilometres

DOROTHY LAKE 13K/4

massif in the south central part of the map area. Defined by Emslie *et al.* (1978), Hope gneiss outcrops extensively in his Ptarmigan Complex but underlies only a small part of the map area of this study. The gneiss weathers buff-white to gray, is primarily leucocratic with rare mafic zones and layers, commonly foliated and locally, on a small scale, layered (Emslie *et al.* 1978). It contains quartz, feldspar, hypersthene, biotite, garnet and sillimanite (Emslie *et al.* 1978) indicating that it has undergone at least one granulite grade metamorphic event which is presumed to be of Grenville age.

No absolute age dates are yet available on the Hope gneiss but Emslie *et al.* (1978) consider that it is probably not older than Aphebian. Mapping during this study suggests the gneiss may be at least in part as old as Archean. This conclusion is supported by a preliminary Rb-Sr date of 2200 Ma obtained on biotite from the Wilson Lake granulite (J. Gittens, personal communication, 1979) which may be correlative with Hope gneiss in the extreme southern part of the Ptarmigan Complex.

Disappointment gneiss (Unit 2)

Disappointment gneiss outcrops south of Red Wine Lake in the southwest corner of the map area. It is commonly pink on weathered and fresh surfaces, less commonly gray or buff-white and consists of fine grained (0.5 mm to 2.0 mm) quartz, feldspar bands up to 2.0 cm wide separated by biotite, muscovite and sillimanite bands of comparable width. In addition, rare garnet is also present. Although coarse grained and of granitic composition in places, it is generally a monotonously uniform banded granodioritic gneiss, cut by deformed aplite and pegmatite dikes.

Within the gneiss, bodies (up to 2.0 km diameter), pods and strings of aligned pods (up to 2.0 m long) of massive to banded amphibolite are ubiquitous. Pods represent metamorphosed, boudinaged diabase dikes and consist of hornblende, biotite, plagioclase, magnetite and minor pyrite. The maximum metamorphic grade of these rocks is amphibolite and is probably due to a Grenvillian event.

The age of a large body of gabbro-diabase, which intrudes basement granite north of Red Wine Lake, must be greater than or equal to 1278±92 Ma, the Rb-Sr date on the Seal lake Group (Wanless and Loveridge, 1977). Several large intrusive bodies of amphibolite within the gneiss can be correlated with the gabbro-diabase and therefore probably have an age greater than or equal to 1278 Ma. The gneiss exhibits at least two periods of deformation, the amphibolites only one, whereas the gabbro-diabase is only mildly deformed and unmetamorphosed. This suggests that the fabric in the amphibolite and probably F_2 in the gneiss is Grenville in age. F_1 is older, and possibly of Hudsonian age. Thus, based on this reasoning, the Disappointment gneiss is probably Aphebian in age.

Wapustan gneiss (Unit 3)

Isolated "rafts" (ranging in size from 2.0 km by 2.0 km to 12.0 km by 4.0 km) of metamorphosed, deformed siliceous rocks, completely surrounded and intruded by little deformed granite of the North Pole Brook complex comprise the Wapustan gneiss. Along with the granite, this gneiss constitutes basement to the Seal Lake Group. Commonly finely banded, mesocratic to leucocratic, the gneiss weathers gray to buff white and consists of quartz, plagioclase, K-feldspar, muscovite, minor biotite and locally, sillimanite, garnet, hornblende, pyrite and pyrrhotite. The predominance of quartz and muscovite as mineral constituents suggests that this unit is mainly paragneiss.

Bodies of massive to banded greenstone (presumably of volcanic origin) up to 1.5 km long, consisting of hornblende, quartz, feldspar and chlorite are present within the gneiss, as well as boudinaged dikes and pods (up to 4.0 m long) of massive to banded amphibolite derived from diabase. Deformed pegmatite and aplite dikes are also common.

The presence of hornblende, biotite, sillimanite and garnet indicates the gneiss has been metamorphosed to amphibolite grade. The granite which intrudes the gneiss is itself intruded by Letitia Lake porphyry, which has a tentative relative age of 1400-1500 Ma. (Brummer and Mann, 1961). Therefore, Wapustan gneiss is older than Helikian. The metamorphism is Hudsonian or earlier in age since the granite exhibits at most a moderate Grenvillian metamorphic-tectonic fabric and in many places is undeformed. In addition to these relationships the polydeformed nature of the gneiss suggests that it is of Aphebian or possibly Archean age.

North Pole Brook complex (Unit 4)

Rocks of this complex form an arcuate band 15 to 25 km wide from east to west across the central part of the map area. The complex consists of plutonic rocks which have been divided on the basis of mineralogy and texture into five subunits. The composition and relative content of hornblende and biotite is highly variable so that in the field, contacts between the various subunits appear to be gradational. Equigranular hornblende, biotite granite (4a) is typically buff-white on weathered surface and gray on fresh surface with a grain size of 2.0 to 5.0 mm. It consists of quartz, orthoclase, plagioclase and biotite with lesser amounts of hornblende and magnetite. Locally, hornblende is the dominant mafic mineral and the composition approaches that of diorite.

Porphyritic hornblende, biotite granite (4b) is identical in mineralogy to the equigranular granite but contains gray, pink or purple phenocrysts (from 1.0 to 5.0 cm long) of orthoclase in a groundmass of average grain size equal to 0.5 cm. Both equigranular and porphyritic granite in places approach granodiorite in composition and commonly contain angular to subangular dioritic inclusions as large as 0.2 m.

Equigranular biotite granite and minor biotite diorite (4c) consist of quartz, orthoclase, plagioclase, biotite, magnetite and rare muscovite. A peculiar texture of randomly oriented feathery biotite crystals somewhat like "quench" texture, is present within this subunit west of Red Wine Lake. Also in this area biotite granite contains large numbers of angular and subangular xenoliths (up to 1.0 m in size) of mafic gneiss, greenstone, diorite and porphyritic mafic rock. Porphyritic biotite granite (4d) is similar to subunit 4b except that biotite is the dominant ferromagnesian mineral. Medium grained monzodiorite and quartz monzonite (4e) were mapped by Emslie *et al.* (1978) and are confined to the Red Wine mountains in the south central part of the area.

Although there is a lack of suitable metamorphic index minerals, the granites within the complex have been metamorphosed during the Grenvillian Orogeny probably to at least greenschist facies. The structural-stratigraphic position of the complex suggests that it is late Aphebian or early Helikian in age.

Gabbro-diabase (Unit 5)

Gabbro, diabase and minor pyroxenite are present within an elliptical east-west trending body north of Red Wine Lake and as smaller bodies and dikes throughout the map area. They consist of plagioclase, pyroxene, hornblende, biotite, magnetite and minor pyrite. The texture varies from gabbroic to diabasic and accumulations of pyroxene form local pyroxenite zones.

Bodies north of Red Wine Lake intrude granite of the North Pole Brook complex suggesting they are early Helikian in age, possibly associated with the Elsonian Harp Lake anorthosite. It has also been suggested (Bailey, personal communication, 1979) that these gabbro bodies may be correlative with the Michael Gabbro south of the Makkovik area to the east.

Letitia Lake Group (Unit 6)

Rocks of this unit occur in a narrow arcuate band 5.0 km wide in the northwest part of the map area. Massive, intermediate to felsic intrusive quartz-feldspar porphyry (6a) lies at the base. This subunit contains buff to white K-feldspar phenocrysts and oval quartz eyes in a green to white, fine grained siliceous groundmass. Also included within this subunit (although it may be an older separate unit) is a minor porphyritic andesite flow. It consists of buff to green, euhedral to subhedral and broken K-feldspar phenocrysts up to 3.0 cm long and oval blue quartz eyes up to 4.0 mm in a green biotite, aegirine groundmass. Quartz filled amygdules and reaction rims around feldspar phenocrysts are common as is zoning in the feldspar phenocrysts. Felsic porphyry is in intrusuve contact with granite of the North Pole Brook complex.

Porphyritic rhyolite, flow-banded rhyolite and tuffaceous equivalents, including ignimbrite, constitute subunit 6b and lie on the flanks and over felsic porphyry of subunit 6a. These rocks contain euhedral and broken feldspar phenocrysts averaging 4.0 mm but up to 1.5 cm in a salmon pink, siliceous aphanitic groundmass and represent extrusive equivalents of the rocks of subunit 6a.

Subunit 6c includes parts of 6a and 6b that have undergone subaerial weathering during late Paleohelikian or early Neohelikian time. At that time, oxidation of porphyry and locally rhyolite along fracture planes resulted in the development of hematite and magnetite in discrete patches of various sizes.

Quartz-orthoclase-muscovite-chlorite-biotite-epidote assemblages indicate a metamorphic grade for these rocks of upper greenschist facies. The age of the metamorphism is Grenville. The Letitia Lake Group has been tentatively correlated with Croteau (now Bruce River Group) volcanics to the east (Brummer and Mann, 1961) which have been dated by Wanless and Loveridge (1972) at 1474±42 Ma by Rb-Sr method. More recent data (Thomas, in press) indicate that Letitia Lake Group rocks have an average composition of comendite and are virtually identical in chemistry to alkali granite of the Arc Lake group. Based on this information it is now thought that the Letitia Lake Group is geochemically correlative with and consists mainly of extrusive equivalents of the Arc Lake group. These facts still may not invalidate the time-stratigraphic correlation with the Bruce River Group.

Arc Lake group (Unit 7)

Rocks of this unit occur in the northwestern part of the map area south of Letitia Lake. Mafic alkali syenite (7a) occurs as oval bodies less than 4.0 km long usually elongate parallel to the foliation. Mafic syenite is dark green to pink-green, exhibits equigranular igneous or relict igneous texture and consists of aegirine, arfvedsonite-riebeckite, aenigmatite, plagioclase, orthoclase, microcline, minor astrophyllite and rarely minor quartz.

Intermediate alkali quartz syenite (7b) is distinguished from felsic syenites and alkali granite by its fresh igneous texture, characteristic tan gray weathering and greater proportion of mafic minerals. The rock is equigranular with an average grain size of 0.75 cm and consists of aegirine, arfvedsonite-riebeckite, aenigmatite, astrophyllite, orthoclase and quartz.

Felsic alkali quartz syenite and alkali quartz-feldspar porphyry (7c) grade into, and are difficult to distinguish from, alkali granite. Rocks of this subunit are white to light gray on weathered surface, porphyritic or pegmatitic and consist of aegirine, arfvedsonite-riebeckite, rosenbuschite, albite, perthite, orthoclase, quartz and minor fluorite. Alkali granite (7d) is porphyroclastic, buff white to light gray on weathered surface and consists of aegirine, arvedsonite-riebeckite, aenigmatite, astrophyllite, rosenbuschite, albite, perthite, microcline, quartz and minor fluorite. The rock is thoroughly recrystallized and lies within an extensive cataclastic zone.

Secondary acicular red-brown biotite within rocks of the Arc Lake group is Grenville in age and indicates a probable metamorphic grade of upper greenschist or lower amphibolite. The age of the group is approximately equal to 1400-1500 Ma, the tentative age range of the Letitia Lake Group which is both intruded by and forms extrusive equivalents of the Arc Lake group rocks.

Red Wine alkaline complex (Unit 8)

Rocks of this unit are confined to two small zones of outcrop in the extreme northwest part of the map area. The terminology and description of these rocks is that of Curtis and Currie (in press) and represents a field subdivision of the units. "Green gneiss" (8a) occurs as stretched pods and bands peripheral to the agpaitic plutons. It consists of jadeitic pyroxene, arfvedsonite, nepheline, feldspar, eudialyte, biotite, apatite, pectolite and aenigmatite. "Blue-black gneiss" (8b) also occurs as stretched pods associated with "green gneiss" and consists of omphacitic pyroxene, arfvedsonite, albite, microcline, nepheline, pectolite, aenigmatite, eudialyte and fluorite. Nepheline syenite and malignite (nepheline syenite with colour index between 50 and 90) (8d) occur as large, irregular pods of coarse grained to pegmatitic rock with igneous or relict igneous textures. These rocks contain arfvedsonite, albite, microcline, nepheline, eudialyte, aenigmatite and aegirine. Based on pyroxene geothermometry, Curtis and Currie (in press) estimate the grade of metamorphism for rocks of the alkaline complex to be middle to upper amphibolite. Their Rb-Sr age of 1345±75 Ma indicates the rocks are of Helikian age and the metamorphism of Grenvillian age.

Seal Lake Group (Unit 9)

Rocks of the lower Seal Lake Group form the approximate northern boundary of the map area. The Bessie Lake Formation (9a) consists of 1280m (Brummer and Mann, 1961) of amygdaloidal to massive green basalt flows interbedded with coarse to medium grained clean to arkosic white quartzite. The base of the formation lies unconformably upon rocks of the Letitia Lake Group and the North Pole Brook complex and is characterized by locally occurring thin wedges of polymictic cobble conglomerate. The clasts consist of rounded, stretched cobbles (up to 0.25 m in length) of quartz porphyry, quartz feldspar porphyry, felsic volcanics and hornblende, biotite granite derived from the underlying rocks. The matrix consists of quartz and feldspar grains (averaging 0.5 mm in diameter), sericite, broken zircon crystals and detrital magnetite. Hematite-magnetite wacke and shale (in part metamorphosed to phyllitic schist) derived from underlying rock, marginally interfinger with, and form discontinuous lenses within, the conglomerate.

The Wuchusk Lake Formation (9b) conformably overlies the Bessie Lake Formation and consists of approximately 6096 m (Brummer and Mann, 1961) of gabbro sills, diabase sills and dikes, siltstone, shale, argillite and interbedded chert. The sills comprise the bulk of this subunit and form prominent ridges, whereas sedimentary rocks weather more readily and are found as minor outcrops in the valleys between ridges.

The typical mineral assemblage in rocks of the Seal Lake Group is albite, epidote, muscovite, quartz and chlorite. This, together with the extensive preservation of primary structures and textures, suggests a metamorphic grade of lower to middle greenschist. Rocks of the Seal Lake Group are Neohelikian in age; the metamorphism is Grenvillian as indicated by a 1278±92 Ma Rb-Sr date obtained by Wanless and Loveridge (1972) on the group.

STRUCTURE

The area can be divided into three blocks in thrust contact with one another. Internally, each block is structurally consistent, the southern and central blocks appearing to have acted as rigid masses during the latest phase of deformation. The southern block is defined by the Red Wine mountains massif consisting mainly of Hope gneiss with minor amounts of diorite, monzodiorite, gabbro and porphyritic granite. Within the block, gneiss is polydeformed and exhibits small scale folding (Emslie *et al.* 1978). Gneissic banding and foliation trends are irregular in orientation. Near the thrust faults which mark the northern boundary of the block, rocks become intensely sheared and the foliation becomes oriented parallel to these faults.

The central block contains Disappointment gneiss, Wapustan gneiss, North Pole Brook complex and parts of the Arc and Letitia Lake Groups which straddle the boundary with the northern block. Lineations and minor fold axes in gneisses in the southern part of the block exhibit predominantly shallow south plunging trends. This is particularly true of Disappointment gneiss where quartz-feldspar bands have been deformed into tight first period isoclinal folds, refolded by a second period of deformation into open to tight folds. First and second period fold axes commonly plunge to the south at angles less than 45°, colinear with the fabric in many of the amphibolite pods. Due to the tightness of this folding, the gneiss in places takes on a distinctive "rodded" appearance with quartz, feldspar segregations forming long narrow south plunging tubes and rods. These structures are associated with thrust faults between the south and central blocks. Gneissosity is more variable but also shows a southerly trend. Within the interior of the block, rocks are undeformed or weakly to moderately foliated commonly in a north-south direction. An exception here is Wapustan gneiss which is intensely deformed and exhibits complex small scale fold interference patterns. In places chevron folding or crenulations are present but most commonly the gneiss is contorted with gneissic banding having no regular trend. In the northern part of this block, rocks are intensely sheared and strongly foliated parallel to the thrust faults between the central and northern blocks.

The northern block consists mainly of rocks of the Seal and Letitia Lake Groups. These have been folded into tight, isoclinal F_1 folds, later refolded into open, to closed isoclinal regional F_2 folds. The F_2 folds are overturned to the north, have axial planes that dip to the south and axes and foliations parallel to the faults between the central and northern blocks. In the northeastern part of the map area, F_2 fold axes have a shallow east or southeast plunge. The unconformity between the Seal Lake Group and underlying rocks of the basement terrain, has to a large degree, been obliterated by thrusting along the boundary between the central and northern blocks.

MINERALIZATION

Rare earth element, zirconium, thorium and uranium mineralization is associated with rocks of the Red Wine alkaline complex (Thomas, 1978a). Anomalous amounts of uranium are associated with rocks along the unconformity between Letitia Lake and Seal Lake Groups relative to the amount of uranium associated with other units in the area. Values of up to 15.5 ppm U were obtained from volcanics, regolith, magnetite grit and conglomerate in the paleoweathered upper part of the Letitia Lake Group, whereas values no higher than 6.3 ppm occur in unweathered rocks of the lower part of the Group. A more complete description of mineralization in the Letitia Lake Group and Red Wine alkaline complex has been given by Thomas (1978b).

Disseminated pyrite and pyrrhotite are present in association with amphibolite pods in Wapustan gneiss. These minerals occur along fractures within the pods and in muscovite rich zones along the contact between the pods and enclosing siliceous gneiss. A minor occurrence of zirconium bearing eudialyte was tentatively identified in intermediate alkali syenite southeast of Letitia Lake. The granite and gneiss terrain which underlies most of the map area is apparently barren of economic mineralization.

ACKNOWLEDGEMENTS

Excellent field assistance was provided by A. Barry, R. Ellis and R. Sheppard. Pilots G. Hattery and S. Powell are thanked for ferrying us safely about the wilds of Labrador. Logistical support was supplied from Goose Bay by Messrs. Tuttle Jr. and Sr.

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F3

STRUCTURE OF AN AREA ALONG THE BOUNDARY OF THE LETITIA LAKE GROUP AND SEAL LAKE GROUP, CENTRAL LABRADOR

by

T.J. Calon* and D.C. Hibbs*

INTRODUCTION

Detailed structural analysis was carried out in a small area (62° 14'W, 54° 15'N) north of Letitia Lake in central Labrador. The area is situated along the boundary of the Letitia Lake Group and the Seal Lake Group (Thomas, 1979) along the northern margin of the Grenville Province. The purpose of the project is threefold: (1) to establish the structural geometry of the rock sequences; (2) to determine and compare the deformation histories of the rocks of the two groups, paying special attention to the relationships between deformation and metamorphism; (3) to develop a kinematic model for the structural evolution of the terrain. Microstructural observations have yielded some preliminary data on the operative deformation mechanisms. The study attempts to resolve some of the problems concerning the position and nature of the Grenville Front Zone in central Labrador. It may also provide information about the structural controls of the setting of mineral deposits elsewhere in the zone.

Aspects of the regional geology of the Letitia Lake area have been discussed by Brummer and Mann (1961), Marten (1979) and Thomas (1979). In this study the lithostratigraphic subdivision proposed by Thomas (1979) has been followed with the exception that the slates and metapsammites overlying the regolith are included in the Letitia Lake Group. This change is based on two observations. First, the regolith appears to grade locally into slates and metapsammites which are discontinuously exposed along the contact between the two groups. It is believed that these features are depositional in nature and that the unit represents localized deposits formed during the weathering process. Contacts between these rocks and the basal members of the Seal Lake Group, on the other hand, are always sharp and tectonic in nature. Secondly, it is found that the conglomerates and quartzites of the Seal Lake Group grade laterally into one another and that both rock types may be underlain by the slates and metapsammites. The latter rocks also occur as pebbles in the conglomerate. The unconformity between the two groups is apparently of a complex nature, but it may be more consistently drawn at the base of the conglomerate - quartzite units.

Previous workers have recognized two deformation events which have affected both the Seal Lake Group and the Letitia Lake Group. D_1 produced east - west trending, horizontal to gently plunging folds whose limbs dip moderately to steeply towards the south. These folds define the structural grain of the area. D_2 produced local shear zones and thrusts, and gave rise to the development of folds with related crenulation cleavages. No attempts were made to date the regional metamorphism with respect to the deformation events. This paper presents a major revision of the deformation history outlined for the area.

STRUCTURAL ANALYSIS

North of Letitia Lake three isolated occurrences of conglomerate and quartzite are found along the boundary of the Letitia Lake and Seal Lake Groups

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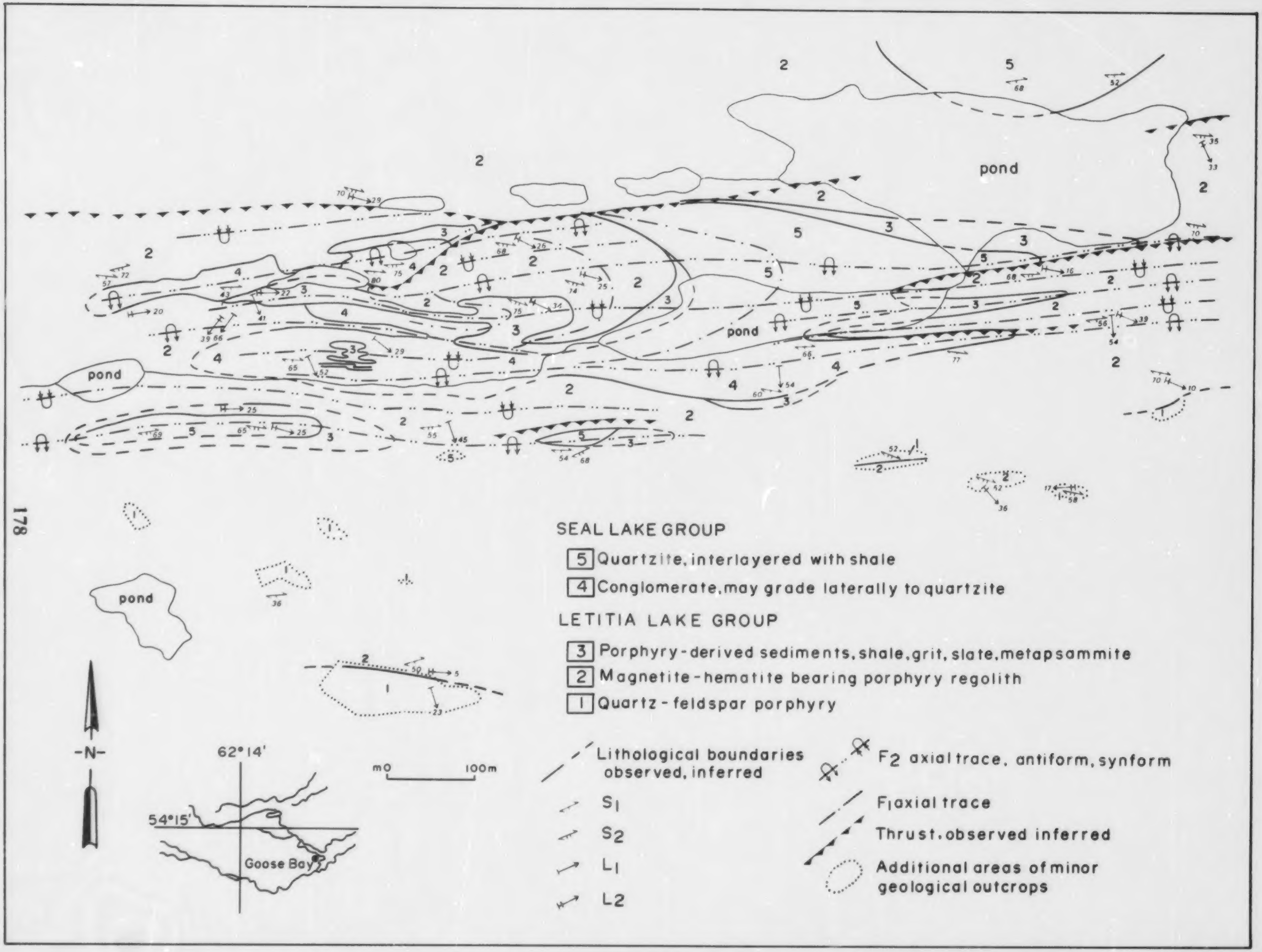
SEAL LAKE GROUP
5 Quartzite, interlayered with shale
4 Conglomerate, may grade laterally to quartzite
LETITIA LAKE GROUP
3 Porphyry-derived sediments, shale, grit, slate, metapsammite
2 Magnetite-hematite bearing porphyry regolith
1 Quartz-feldspar porphyry
Lithological boundaries observed, inferred
S1
S2
L1
L2
F2 axial trace, antiform, synform
F1 axial trace
Thrust, observed inferred
Additional areas of minor geological outcrops
pond
-N-
62°14'
54°15'
Goose Bay
m0
100m

(Thomas, 1979). The outcrops of the bodies are elliptical in shape with the longest dimension parallel to the east - west regional structural trend. Aspect ratios of the outcrop areas of the bodies range up to 10:1. The bodies are situated at different structural levels as measured with respect to a penetrative axial plane foliation developed in the area. Each of the bodies is completely surrounded by outcrop of the older regolith.

The central body has almost continuous exposure and was selected for surface mapping and analysis of small scale structures. Three generations of structures have been recognized on the basis of overprinting criteria and of relationships between deformation and metamorphism using microstructural criteria. The deformation sequence comprises the development of two generations of fold structures (F_1 and F_2) on various scales and a younger faulting event. The deformation history is described below, followed by a discussion of the large scale structural geometry of the area.

F_1 structures

F_1 structures are penetratively developed in all rock units in the area. A well developed axial plane foliation (S_1) is observed which varies in morphology for different rock types. In most cases it is an anastomosing type of slaty cleavage defined by an alignment of layer silicates and preferred dimensional orientation of minerals such as quartz and feldspar. In fine grained rocks a mineral elongation lineation (L_1) is developed in the S-plane; it is particularly common in the quartzites. The conglomerates show a L>S fabric defined by slightly flattened but extremely elongated pebbles. In most cases the foliation is parallel to the primary compositional layering, but in a few conglomerate localities a small angle between the S-planes has been observed. F_1 folds are common in most multilayered sequences, but they are extremely difficult to recognize. They range usually from microscopic to mesoscopic, and are asymmetric, tight to isoclinal and reclined. Fold axes are parallel to the mineral lineation. Large scale F_1 folds have not been observed, but they can be inferred on the basis of bedding/cleavage relationships, asymmetry of small scale folds and lithostratigraphic criteria. The axial traces of a number of F_1 folds have been determined in the central and eastern part of the conglomerate - quartzite outcrop. In the western part of the outcrop the position of these traces is uncertain.

The F_1 structures show a very constant orientation pattern. S_1 planes dip moderately to steeply towards the south. Fold axes and L_1 have a pitch of 70° from east in the S-plane; they constitute a transverse linear element with respect to the regional structural trend.

Microstructures related to the first deformation event show evidence for dynamic recrystallization of muscovite and quartz. Pressure solution features have been observed in the conglomerates and in detrital quartz grains in quartzite. The deformation is almost entirely of a ductile nature, and probably occurred at the peak of metamorphism.

F_2 structures

F_2 structures are found in all rock units in the area, but their intensity of development is less than observed for the F_1 structures. In the conglomerates evidence is found that the amount of strain related to F_2 folding is comparatively small. F_2 folds ranging from microscopic crenulations to large scale, close to tight folds with short wavelengths and large amplitudes are common. They are steeply inclined with axial planes dipping southwards and they usually have S-shaped asymmetry when viewed down plunge towards the east. A crenulation cleavage is commonly developed parallel to the axial plane of the folds. In the slates and metapsammites the foliation has the morphology of a differentiated layering which can be easily mistaken for bedding. An irregular crenulation lineation (L_2) is developed parallel to F_2 fold axes. The linear elements are horizontal or gently plunging towards east or west, but they show a weak tendency to rotate in the S_2-plane towards transverse positions. Large scale F_2 synforms and antiforms are easily observed in outcrop or they can be inferred on the basis of asymmetry of small scale folds. In the field the axial traces can be readily mapped due to the fact that the fold hinges show abundant quartz veining. The large F_2 folds define the structural grain of the area. These folds have been referred to by previous workers as F_1 structures. In many localities, however, they can be seen to overprint F_1 folds.

Microstructures related to the second deformation event show evidence for cold working accompanied by minor recovery; recrysallization is subordinate. On the other hand, the occurrence of differentiated layering and quartz veining indicate that fluid-assisted diffusion processes may also have operated. It is probable that the deformation occurred under waning conditions of metamorphism in the ductile field.

Faults

Thrust and high-angle reverse faults break the continuity of the F_1 and F_2 fold structures. These faults are usually developed parallel to the limbs of macroscopic F_2 folds, but they do not show any preference, at this scale of mapping, to cut off either synformal or antiformal closures as has been suggested by previous workers. Faults are also developed parallel to major lithological contacts where a large competency contrast between the adjacent rocks exists. Displacements along the faults appear to be relatively small. Movement directions inferred on the basis of slickensides and the style of minor drag folds indicate transport towards the north. The fault zones are often extensively chloritized.

INTERPRETATION OF GEOMETRY AND A KINEMATIC MODEL

The most important features of the map in terms of its structural geometry are: (1) the closed outcrop pattern of the younger rocks of the Seal Lake Group, which occupy the core of a large scale refolded fold; (2) the inverted nature of the stratigraphy in the southern and central part of the area and along a short segment of the northern boundary of the conglomerate - quartzite sequence, which is interpreted to be due to F_2 folding; (3) the contrasting orientation patterns of the F_1 and F_2 folds. The kinematic model explaining the structural geometry and evolution of the area must be consistent with the above features.

The closed outcrop pattern of the Seal Lake Group suggests the presence of a doubly plunging fold. The overall eastward plunge of F_2 fold axes over the structure, however, rules out the possibility that the geometry of the fold is due to an interference pattern between F_1 and F_2 folds. It is therefore reasonable to assume that the F_1 structure was internally closed prior to F_2 folding.

Tubular or sheet folds provide the geometry required by the field data. These structures develop by rotation of fold axes, which are originally at a high angle to the X direction of the mean strain ellipsoid, towards X during progressive deformation at highs strains in both pure and simple shear. Initially the fold axes may be subparallel to the intermediate axis of the strain ellipsoid, for example in the case of simple shear. In the final state the long axis of the tube will be parallel to X and signifies the tectonic transport direction. Such structures are common in mylonite zones (Bell, 1978) and in ductile thrust nappes (Williams and Zwart, 1977).

In the studied area, sheet folds have not been observed on a small scale, but many other features are consistent with the proposed geometry. F_1 deformation is associated with high strains. The F_1 axes are parallel to a stretching lineation which defines the X direction and which is transverse to the trend of the Grenville Front Zone. The inversion of the stratigraphy, the northwards facing nature of the F_1 structures, and on a larger scale, the metamorphic zonation (Thomas, personal communication 1979) all indicate that older and more deep-seated rocks have been transported northwards over younger, higher level rocks. In this context it seems probable that L_1 signifies the transport direction.

The geometry of the F_2 folds is not necessarily in conflict with the movement pattern proposed for F_1 deformation. The fold axes may have developed close to parallel with the Y axis of the mean strain ellipsoid. The tendency of the axes to rotate towards transverse postions in conjunction with the northwards vergence of the folds indicates that a similar movement path was followed, but that much lower strains were attained during F_2. A possible explanation for this point may be that a transition from predominantly ductile to brittle deformation conditions occurred with decreasing temperature. The faults which are geometrically strongly related to the F_2 folds may have developed during the late stages of F_2 deformation.

An elegant kinematic model for the development of ductile thrust belts involves progressive simple shear (for example, see Escher and Watterson, 1974). The structural style of the studied area is consistent with all aspects of this kinematic model, but other more complex movement patterns may be equally valid. Notwithstanding possible kinematic complexities, it can be concluded that the studied area is part of a ductile thrust belt in which large strains were obtained during Grenvillian deformation. The structural style of the area resembles that of many other segments of the Grenville Front.

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GEOLOGY OF THE BENEDICT MOUNTAINS AND SURROUNDING AREAS 13J (east half) and 13I, LABRADOR

by

Charles F. Gower

INTRODUCTION

Reconnaissance geological mapping (1:100,000) during the 1979 field season covered the area shown in the accompanying map. Emphasis was given to the well-exposed coastline with most of the sparse interior outcrops visited by helicopter. Selected foot traverses were done in the more complex, better exposed areas. Mapping was done by C. Gower with contributions, especially in areas of felsic volcanics, from D. Bailey and A. Doherty.

The objectives of the work were (i) to map the eastern extension of the Central Mineral Belt (defined by Smyth *et al.*, 1978), and thus provide a basis for assessing the mineral potential of the region in terms of Central Mineral Belt metallogenesis; and (ii) to further use this geological framework as a starting point for deciphering Grenville and pre-Grenville geological histories (and associated mineral potential) in the Grenville Province immediately to the south.

REGIONAL SETTING AND GEOCHRONOLOGY

The 1:250,000 map of Stevenson (1970) is the most recent and comprehensive report available. Stevenson recognized a broad subdivision of massive granitoid rocks in the north and generally gneissic rocks to the south. These areas are separated by a major east-southeast trending shear zone (here referred to as the Benedict Fault) which he interpreted as marking the northern boundary of the Grenville Province. Present work has confirmed this two-fold division.

In addition to the massive granitoid rocks north of the Benedict Fault, several areas of felsic volcanic rocks have been mapped and an older group of foliated and gneissic rocks identified. All three units are intruded by deformed and, later, rectiplanar mafic dikes.

Stevenson reports K-Ar (biotite) ages of 1580±50 Ma and 1425±50 Ma for samples from the massive granitoid unit. Grasty *et al.* (1969) have dated some of the mafic dikes intruding the granitoid rocks, obtaining ages ranging from 972±18 Ma to 1600±20 Ma (K-Ar, whole rock).

The southern area, mapped by Stevenson as paragneiss, is reinterpreted here as metamorphosed granitoid rock with minor remnants of supercrustal rock - largely arenaceous metasediment and felsic pyroclasts. A tentative subdivision of foliated to gneissic rocks and well-banded gneiss is proposed. Much of the interior outcrop consists of a variable suite of rocks ranging from diorite to ultramafite, and collectively referred to as Michael Gabbro (Fahrig and Larochelle, 1972).

Stevenson reported a K-Ar (biotite) age of 1165±40 Ma on "paragneiss" and Grasty *et al.* (1969) obtained an age (K-Ar, muscovite) of 917±11 Ma on "gneissic" country rock intruded by mafic dikes. Reported ages for mafic intrusions within the gneissic rocks are 1340±120 Ma (K-Ar, whole rock; Stevenson, 1970) and 1457±107 Ma (Rb-Sr, whole rock; $\lambda = 1.42 \times 10^{-11}$ /yr; Wanless, *in* Fahrig and Larochelle, 1972).

GENERAL GEOLOGY

Archean or Aphebian (Unit 1)

Although early workers (*e.g.* Kranck, 1953) report gneissic rocks as the bulk of the bedrock between Pottles Bay and Cape Harrison, this is very misleading and gneissic rocks are largely confined to the peninsula north of Jeanette Bay.

The rocks are strongly foliated and gneissic tonalites and granodiorites and are discordantly intruded by massive granite. As geochronological data are absent for these rocks, and because there are ambiguities attached to interpretation of the north-trending structural fabric (which could be Aphebian or Archean), the age of these rocks is uncertain. Two broad divisions are recognizable; namely, (i) fine to medium grained tonalite in the west and (ii) a variable suite of diorite to granodiorite in the east.

The dark gray weathering tonalites are heavily injected by a medium grained, buff-yellow granodiorite to form a migmatitic mixture. In places the buff-yellow granodiorite is dominant and only nebulitic remnants of tonalite remain. Field appearance suggests a close-to-*in situ*, partial melting mechanism for generating the latter. Within the tonalites, there are highly reworked and injected remnants of fine grained felsic and siliceous banded rocks which may be relicts of a volcanic and metasedimentary assemblage. Locally, this material is extensive, *e.g.* The north part of Jigger Island.

The dioritic and granodioritic rocks are extremely variable, both in composition and fabric. Diorite and monzodiorite are abundant on the north side of Jeanette Bay. Though strongly foliated, these rocks are nowhere well-banded gneisses. Further north, heterogeneous granodiorite, with a fabric ranging from massive to well banded gneiss, is present. Some contains K-feldspar megacrysts and accessory garnet. Quartzofeldspathic lenses and mafic enclaves are ubiquitous. At False Cape there are adistinct group of garnet-bearing, mafic-rich monzodiorites. Garnet locally exceeds 5% in these rocks.

Aphebian ? (Unit 2)

The age of this group of felsic volcanic and metasedimentary rocks is uncertain. One choice is to correlate the rocks west of Mount Benedict with similar rocks forming the Upper Aillik Group north of Witch Doctor Lake (Bailey, 1978). These have been dated at 1776±2 Ma (Kontak, 1979) and 1673±8 Ma[*] (Watson-White, 1976) ($\lambda = 1.42 \times 10^{-11}$ /yr) and are thus Paleohelikian using the 1800 Ma Aphebian-Helikian boundary of Stockwell (1972). A second choice is to correlate them with more deformed rocks south and east of Deus Cape. The latter have a definite north-trending structural fabric, presumably no younger than Hudsonian, which means that the rocks are Aphebian, assuming deformation prior to 1800 Ma. The rocks occur in five main areas.

West of Mount Benedict

Agglomerates and coarse tuffs are abundant on the west side of the belt with clasts commonly exceeding 20 cm diameter. The fragments are generally rhyolitic and both quartz and feldspar porphyries are present. In the central and eastern parts, very fine grained rhyolite is common, with both flows and fine grained tuffs being present. Crossbedded arkose/quartzite, in association with conglomerate/agglomerate, is exposed on the coast at the eastern margin of the belt. Quartz-feldspar porphyry, probably

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[*] The sample locations of Watson-White suggest that a heterogeneous suite of rocks was dated. The pooled isochron may therefore have reduced validity (Bailey, personal communication)

LEGEND

VARIOUS AGES - MOSTLY PRE-HADRYNIAN

▬	Dikes, sills and irregular bodies of diorite, gabbro and ultramafite; metamorphosed in part.

NEOHELIKIAN (Reworked Paleohelikian and Earlier)

4a	Quartz-rich continuously banded gneiss; protolith probably arenaceous metasediments.
4b	Fine grained metafelsic volcanic and pyroclastic rocks.
4c	Highly garnetiferous "lensy"-banded gneiss; protolith possibly intermediate pyroclastic rocks.
4d	Garnet-bearing foliated to gneissic biotite granodiorite; metaplutonic rocks.
4e	Garnet-bearing foliated to gneissic biotite granodiorite with megacrysts/augen of K-feldspar; metaplutonic rock.
4f	Garnet-bearing discontinuous to well-banded diorite, tonalite and granodiorite gneiss; protolith probably igneous.

Paleohelikian

3a	Coarse grained equigranular biotite granite.
3b	Coarse grained hornblende-biotite granodiorite/granite.
3c	Coarse grained biotite granodiorite with K-spar megacrysts.
3d	Coarse grained biotite-hornblende granodiorite/quartz monzonite with very large K-spar megacrysts.
3e	Coarse grained alkali granite.
3f	Medium to coarse grained syenite, locally quartz syenite or monzonite.
3g	Variable group of syenite, monzonite and granodiorite rocks; may include remnants of Unit 1.
3h	Coarse grained hornblende alkali syenite.
3i	Medium to coarse grained diorite, monzo-diorite.
3j	Mafic-rich coarse grained syenite to monzonite (strongly foliated due to proximity to major fault).

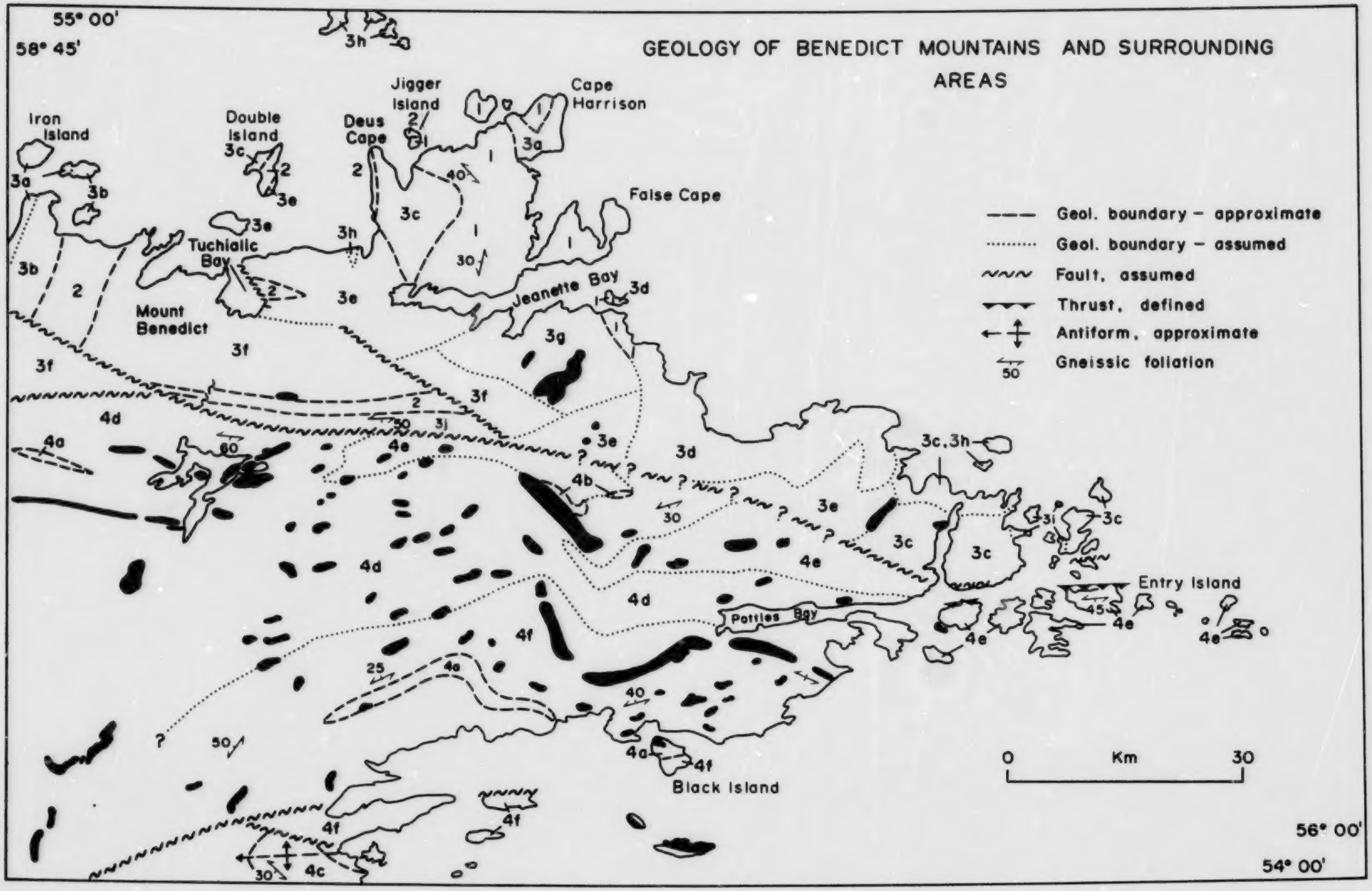
APHEBIAN?

2	Metarhyolitic flows and fragmental volcanic rocks, subsidiary meta-arkose and quartzite, minor fine grained amphibolite.

APHEBIAN OR ARCHEAN?

1	Strongly foliated and gneissic garnet-bearing tonalite and granodiorite, locally migamatitic and megacrystic.

Note: Granitoid terminology follows IUGS recommendations.
Granitoid rocks massive unless stated otherwise.



GEOLOGY OF BENEDICT MOUNTAINS AND SURROUNDING AREAS

55° 00'
58° 45'
56° 00'
54° 00'
Iron Island
Double Island
Deus Cape
Jigger Island
Cape Harrison
False Cape
Tuchialic Bay
Mount Benedict
Jeanette Bay
Pottles Bay
Entry Island
Black Island
3a
3b
3c
3d
3e
3f
3g
3h
3i
3c, 3h
1
2
4a
4b
4c
4d
4e
4f
Geol. boundary – approximate
Geol. boundary – assumed
Fault, assumed
Thrust, defined
Antiform, approximate
Gneissic foliation
50
40
30
60
25
45
0
Km
30

hypabyssal, is also common on the eastern side of the belt.

The sequence has been injected by closely spaced, southeast-trending diabase dikes which exceed 50% of the total outcrop in places. It is certainly these dikes that led Stevenson (1970) to map a large intrusion of mafic rock in this area.

Double Island

Both the grade of metamorphism and the proportion of sediments are higher in the supercrustal rocks on Double Island than west of Mount Benedict. The volcanic rocks are probably rhyolite lavas but strong shearing and associated microgranite injection has destroyed most of the primary fabric. More obvious, especially on the northeast part of the island, are well banded, locally strongly folded quartzites. Some lensy, siliceous rocks, interpreted as pyroclastics, are associated with structureless, fine grained feldspar porphyries, probably intrusive in origin. A wide band of uniform fine grained amphibolite, most obvious on the west coast, lacks primary fabric and could be either intrusive or extrusive.

Tuchialic Bay

Two rock types can be recognized; namely, (i) gray and pink, structureless, very fine grained rock with large, scattered saussauritized feldspar phenocrysts (this is interpreted as a hypabyssal intrusion) and (ii) well banded ash-flow rhyolite showing eutaxitic structures. These rocks are intruded by cogenetic rhyolite dikes.

South of the Benedict Mountains

This easterly trending belt consists of felsic tuffs with subsidiary lavas. Alternation of well banded, cream, pink and green weathering crystal tuffs and ashes are particularly common at the western end. The lavas are mostly white weathering, very fine grained rhyolites. Associated with both rock types are hypabyssal feldspar porphyries, locally containing plagioclase phenocrysts up to 2 cm long.

South of Deus Cape

The rocks in this area compare closely with those on the west side of Double Island, but are more strongly deformed. Very fine grained, buff weathering felsic rock with a streaky, lensy fabric dominates and is ubiquitously injected by anastomosing granitic material. Associated with these rocks are gray weathering, flaggy, very siliceous rocks, most likely quartzite or graywacke. Primary fabric has been almost obliterated, except for one area of probable lapilli tuff.

Paleohelikian (Unit 3)

The subdivision of the massive granitoid rocks has been made with the assistance of numerous stained slabs. Granitoid terminology follows IUGS recommendations (Streckeisen, 1973). No age relationships are implied by the order of the units in the legend.

Coarse grained equigranular biotite granite (3a)

The rock on Iron Island, and the mainland immediately south, is very coarse grained (greater than 2 cm); it is pink weathering, massive with rare mafic enclaves and very few minor granitic intrusions. Fluorite is a very common accessory mineral.

The granite at Cape Harrison is very leucocratic; color index is less than 4. Extensively chloritized biotite, sericitized plagioclase, and a granulated matrix, together with a well defined photolineament, confirm the southerly trending fault postulated by Stevenson (1970) in this area.

Coarse grained hornblende-biotite granodiorite/granite (3b)

In contact with felsic volcanics west of Mount Benedict, Unit 3b is a granodiorite with K-feldspar megacrysts. Progressing north, the plagioclase proportion decreases and both quartz and plagioclase grain sizes increase to give a coarse grained, crudely equigranular rock gradational into Unit 3a. Thus, Unit 3b may be simply a border facies of Unit 3a. In contrast to Unit 3a, hornblende (altered to biotite + epidote) is the dominant mafic phase in Unit 3b. Mafic enclaves and minor granitic intrusions are uncommon. Fluorite occurs in some shears.

Coarse grained biotite granodiorite with K-feldspar megacrysts (3c)

The granodiorite southeast of Deus Cape has a seriate to megacrystic texture with K-feldspar up to 4 cm. The massive interior grades into a recrystallized, strongly foliated border, showing greater compositional variability. Though biotite is dominant, hornblende occurs rarely.

The megacrystic granodiorite northeast of Pottles Bay differs from the granodiorite southeast of Deus Cape in having a higher mafic content, less conspicuous seriate texture, and lower quartz content.

Coarse grained biotite-hornblende granodiorite/quartz monzonite with very large K-feldspar megacrysts (3d)

In typical samples, almost all the K-feldspar is concentrated into megacrysts which may exceed 7 x 4 cm. The megacrysts are generally euhedral, zoned and contain inclusions of quartz and plagioclase. Hornblende is the dominant mafic mineral but is partially pseudomorphed by biotite. Allanite, up to 1 cm, and sphene are unusually common accessory phases. The rock contains enclaves of gneiss and amphibolite and is intruded by microgranite dikes.

Coarse grained alkali granite (3e)

In the alkali granite east of Tuchialic Bay, K-feldspar exceeds 60%, plagioclase is less than 10%, and chloritized biotite less than 5%, except in the border areas where plagioclase content is slightly greater. Fluorite is a common accessory phase and is also found in fractures associated with epidote. Mafic enclaves and minor granitic intrusions are rare.

The two southerly areas contain a texturally variable group of K-felspar-rich granites and it is unlikely that the mapped areas represent individual intrusions. Both areas are characterized by less than 3-4% mafic minerals, mainly chloritized biotite.

Medium to coarse grained syenite, locally quartz syenite or monzonite (3f)

Characteristically, these rocks contain ragged white plagioclase in a K-feldspar-mafics groundmass though the contrast in grain size is insufficient to describe the rock as megacrystic. Pyroxene, hornblende and biotite are all present, showing alteration to low-temperature phyllosilicates. Near the borders of the intrusion, the rock is medium grained, more variable, and more commonly monzonite. An area of fine to medium grained rock on and south of Mount Benedict may indicate proximity to the roof of the intrusion.

Variable group of syenite, monzonite and granodiorite (3g)

These rocks are grouped primarily by default from other defined units. The syenites and monzonites are medium and coarse grained with hornblende and biotite as mafic phases. They may represent an eastern border phase of Unit 3f. The granodiorites are variable, locally megacrystic and moderately foliated and perhaps should be assigned to Unit 1.

Coarse grained alkali syenite (3h)

Dark gray to chocolate-weathering syenites were reported by Christie *et al.* (1953) and described by Stevenson (1970). However, both authors include some of the texturally and compositionally distinct rocks of Unit 3f. Microcline perthite comprises up to 65% of the rock with subsidiary plagioclase, quartz, hornblende and biotite.

The rocks were emplaced after Units 3c and 3e, truncating shear zones in the former. Stevenson suggested that the syenites may be younger than the mafic dikes. Although the syenite may postdate the deformed net-veined dikes, they are certainly intruded by later, rectiplanar mafic dikes.

Medium to coarse grained diorite, monzodiorite (3i)

These brownish gray rocks consist dominantly of plagioclase (greater than 60%) with quartz and K-feldspar as accessory felsic minerals, and hornblende, pyroxene and biotite as mafic phases. Ultramafic rocks are associated on the eastern side. In view of the contrast to the generally alkali granitoid rocks, it is possible that these rocks represent an unusually feldspar-rich phase of the gabbros. The unit may be reassigned after thin section and chemical data are available.

Mafic-rich, coarse grained syenite to monzonite (3j)

This very distinctive rock type extends over a strike length of 35 km parallel to the Benedict Fault. K-feldspar and some plagioclase augen are contained within a protomylonitic matrix of quartz and mafic minerals, the latter mainly chlorite.

Helikian (Unit 4)

All the rocks south of the Benedict Fault were deformed during the Grenville Orogeny and are grouped as Helikian, although reworked Aphebian, and possibly Archean rocks may be present.

Large segments of the area are underlain by strongly foliated and gneissic biotite granodiorite (Unit 4d), grading into tonalite, diorite or granite locally. These rocks are totally recrystallized, generally medium grained and have a color index less than 10. Discontinuous quartzofeldspathic layers and elongate mafic enclaves define a crude banding in places. Garnet and hornblende porphyroblasts occur, especially in the quartzofeldspathic layers.

Two areas of foliated to gneissic biotite granodiorite with megacrysts/-augen of K-feldspar (Unit 4e) have been mapped. Smaller areas, not shown on the map, occur elsewhere close to the Benedict Fault. These rocks are mostly deformed megacrystic granodiorites. The unit north of Pottles Bay may be, in part, a deformed equivalent of Unit 3c further east.

On the islands east of Pottles Bay, zones of well banded gneiss alternate with more uniform rock containing K-feldspar augen. The gradational boundaries between the two indicate a common granitoid pluton protolith.

Fabric is the main contrast between the rocks west and south of Pottles Bay (Unit 4f) and those further north. Unit 4f consists mostly of well-banded biotite granodiorite to tonalite gneiss with layers defined by subtle mineralogical and grain size heterogeneities and more obvious quartzofeldspathic zones. The latter contain abundant garnet and hornblende porphyroblasts. Immediately south of Pottles Bay, the gneisses are mostly dioritic with some areas of almost uniform metadiorite. Monzonite is a common rock type in the southwest part of Unit 4f.

Contrasting to Units 4d, 4e and 4f are creamy, white or rusty weathering, continuously banded rocks (Unit 4a) interpreted as derived from a metasedimentary protolith. These rocks are very siliceous with biotite, muscovite or, less commonly, feldspar as other essential phases. Interleaved tonalitic gneiss and quartzofeldspathic metasediments are well exposed on Black Island. Some finer grained metasediments are also present.

One area of deformed felsic volcanics was mapped (Unit 4b). Feldspar porphyritic rhyolite is interbedded with very fine grained tuffaceous sediment and lapilli tuff. Much of the rhyolite is structureless and could be hypabyssal. Some of the volcaniclastic sediments are deformed to muscovite-biotite schist.

Unit 4c may also have been derived from a volcanic protolith. The rocks have a distinct "lensy" banding suggesting a deformed agglomerate or breccia. The mineralogy is very variable over small areas and the rock commonly highly garnetiferous (greater than 35%). Dispite a dark weathering appearance, much of the rock is silica-rich.

Various ages - dikes, sills and irregular mafic bodies

In the northern part of the area, two clearly distinct groups of mafic intrusions can be identified. An older group of dikes commonly has a net-vein appearance and shows external deformation. The net-veining has been described by Elders and Rucklidge (1969). The younger group of dikes are rectiplanar and undeformed.

In the southern area, four groups of mafic rock can be distinguished; namely, (i) fine to medium grained massive, equigranular diabase, (ii) medium grained, massive, equiganular diabase with a distinctive purplish weathering tinge, (iii) an assortment of coarse grained ultramafites, and (iv) gabbro-leucogabbro.

STRUCTURE AND METAMORPHISM

North of the Benedict Fault

The strongly foliated and gneissic rocks of Unit 1 show complex isoclinal folding in detail but regionally form a north-trending terrain which has suffered later open folding about east-trending, upright axial surfaces. This later folding may have resulted from deformation during the Grenville Orogeny. Isoclinal folding is also apparent in the metasediments of Unit 2 but a lack of marker horizons prevents delineation of major structures. The rocks have been metamorphosed to lower-middle amphibolite facies with retrograde greenschist effects.

The granitoid rocks of Unit 3 are generally massive and structureless. Locally, east-southeast trending shears or fracture cleavage is present and interpreted as the result of Grenville deformation. Apart from minor deuteric alteration, the rocks are unmetamorphosed.

Two southeasterly trending splay faults are present north of the Benedict Fault. The western fault is obvious from aeromagnetic and ground lineaments as well as lithology distribution. The eastern fault is suggested by a poorly defined photolineament. The orientation of these faults, coupled with the geometry of minor folds observed on the coast, suggests a dextral component to the predominantly reverse movement (south-side-up) on the Benedict Fault.

South of the Benedict Fault

Three main folding events can be recognized. The earliest folds are isoclinal and have north-trending axes. These folds were refolded along major east-trending structures. An antiform in the southern part of the area can be extrapolated eastwards through the islands of Groswater Bay. An poorly defined synform can be interpreted north of this with its axial trace passing south of Pottles Bay.

These major folds are refolded by northeasterly trending folds which seem to be confined to the eastern part of the region. They are tentatively interpreted as the product of the same stress field that was responsible for the dextral movement on the Benedict Fault.

The grade of metamorphism is middle to upper amphibolite facies. Garnet and hornblende porphyroblasts are abundant in the tonalitic gneiss and tend to be concentrated in quartzofeldspathic layers. No alumina silicates were observed in hand specimens but Stevenson (1970) has reported sillimanite and cordierite and the Metamorphic Map of the Canadian Shield shows a kyanite locality on the islands in the extreme eastern part of the region (Geological Survey of Canada, Map 1475A).

MINERALIZATION

Malachite staining, associated with shears in pink medium grained granite, was observed on an island 7 km south of Cape Harrison. Copper mineralization has also been reported on Black Island. It is associated with arenaceous metasediments also showing a pink staining, possibly erythrite, in epidote-rich pods.

Molybdenite has been reported from the area and a prospect drilled at the south end of Jay Lake. A new molybdenite locality, in veins associated with pyrite, was found on Entry Island.

Pyrite, in irregular veins, was located in felsic volcanics west of Mount Benedict. No mineralization was found associated with any of the other felsic volcanic areas. Many of the metasedimentary horizons in the southern area are pyritic.

Fluorite is a ubiquitous accessory phase in some of the granites, especially 3a, 3b and 3e, and also occurs in shears associated with epidote in the same rocks.

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CENTRAL LABRADOR TROUGH PROJECT

by

R.J. Wardle

Regional mapping in the central part of the Labrador Trough,, *i.e.* that part between latitude 54°00'N and the Quebec border, has essentially been completed and no new field work was carried out during the 1979 field season. The geology of the area is presently being written up as a final report to be accompanied by two 1:100,000 scale colored maps and several 1:50,000 sheets.

Two weeks of the 1979 field season were spent in a general geological reconnaissance of areas of the Churchill and Grenville Provinces, east and southeast of the Labrador Trough, in order to determine the most appropriate direction in which to extend mapping from the Trough.

As a result it is likely that future mapping, commencing in 1980, will be centered on Churchill Falls and will concentrate on the area of the Churchill/Grenville Province boundary between the Labrador Trough and Churchill Falls.

Reconnaissance work in the area has revealed that much of the area supposed by previous workers to be underlain by gneissic rocks is in fact dominated by extensive bodies of granite in varying states of deformation. Interspersed within the granites are several small areas of gneiss, volcanics and sedimentary rocks. The geology and mineral potential of this area is only poorly defined and will be revised during a 1:100,000 or 1:250,000 mappping project.

Two Rb/Sr age dates were obtained during the winter of 1978-79 which have significance for the geology of the southern part of the Labrador Trough that lies between latitude 54°00'N and the Grenville Front. Both dates were provided by C. Brooks of the University of Montreal.

1.) The age of the Shabogamo Gabbro has been determined at 1685±60 Ma.

    This is an eighteen point errochron obtained by the combination of three separate isochrons determined from three sample group sites in the areas of MacLean Lake (8 samples) north Gabbro Lake (6 samples) and south Gabbro Lake (4 samples). Although the date is an errochron the fact that it is based on three isochrons from sample sites up to 30 km apart is considered good evidence that the date reflects the age of crystalization of the Shabogamo Gabbro and that the gabbro forms a body of uniform age in this part of the Trough.

    This early Paleohelikian age for the gabbro requires that the Sims Formation, which is locally intruded by the gabbro (Ware, 1979) also be Paleohelikian.

2.) A six point errochron corresponding to an age of 1540±40 Ma has been obtained from felsic volcanic rocks of the Blueberry Lake group (Wardle, 1979).

    On this basis the group postdates the Shabogamo Gabbro and might be considered equivalent to the Bruce River Group of eastern Labrador (Smyth *et al.*, 1978).

Recent work by Rivers and Noel (this volume) however, has shown that sedimentary rocks believed to be part of the Blueberry Lake group (Wardle, 1979) have been intruded by the Shabogamo

Group, thus casting doubt on the validity of the errochron as an age of extrusion.

Further work is obviously required before the age of the Blueberry Lake group can be firmly established.

Details of both Rb/Sr determinations are included in an internal report on geochronology in Labrador (Brooks, 1979) held on open file at the Mineral Development Division, St. John's.

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TAMARACK RIVER FORMATION, SIMS LAKE - MENIHEK LAKE AREA WESTERN LABRADOR

by

M.J. Ware*

INTRODUCTION

The Tamarack River Formation is a newly defined sedimentary sequence (Ware and Wardle, 1979) outcropping in the southern part of the Labrador Trough between Menihek Lake and Sims Lake (Figure 1). Originally, the strata of the Tamarack River Formation were assigned by Eade (1949), Tiphane (1951) and Fahrig (1967) to the Aphebian Knob Lake Group of the Labrador Trough. However, MacDonell and Walker (1975) included the Tamarack River Formation sequence into the Helikian Sims Formation based on lithologic and structural similarities between the two formations. Recent studies by Ware and Wardle (1979) suggested that the Tamarack River Formation lies unconformably on the Knob Lake Group but also demonstrated that the unit is unconformably overlain by the Sims Formation in the Muriel outlier (Figure 1).

During the past summer two weeks were spent studying the sedimentology, stratigraphy and contact relationships of the Tamarack River Formation. This work, together with similar studies on the Sims Formation carried out in 1978, will form the basis of an M.Sc. thesis at M.U.N. by the author.

New information arising from this past summer's work necessitates revision of Ware and Wardle's (1979) description of the Tamarack River Formation. The formation is now found to consist of four mappable members with a probable total thickness of 300 m and was locally penetratively deformed prior to deposition of the Sims Formation. The recognition of a major period of deformation (i.e. the Hudsonian Orogeny) separating the Tamarack River and Sims Formations requires abandonment of the nomenclature used by Ware and Wardle (1979) which involved the combination of the Tamarack River and Sims Formations into the Sims Group and the renaming of the Sims Formation as the Muriel Formation.

GENERAL GEOLOGY

The Tamarack River Formation lies at the southern end of the Labrador Trough just north of the Grenville Province. At this latitude the Labrador Trough consists of very poorly exposed sedimentary and volcanic strata belonging to the Aphebian Knob Lake Group (see legend, Fig. 1). The Tamarack River Formation appears to unconformably overlie the Knob Lake Group, is probably at least 300 m thick, and consists of four informally defined members. Both the Knob Lake Group and Tamarack River Formation were deformed in the Hudsonian Orogeny *circa* 1800 Ma (Stockwell, 1972).

The Sims Formation, a sedimentary sequence of basal conglomerate, arkose and orthoquartzite, up to 700 m thick, rests unconformably on both the Tamarack River Formation and Knob Lake Group.

The Knob Lake Group, the Tamarack River and Sims Formations were subsequently intruded by the Shabogamo Gabbro at 1685 Ma (Brooks and Wardle, in preparation) The latest event in the area was the Grenvillian Orogeny *circa* 1000 Ma (Stockwell, 1972) which produced northeast-southwest trending structures in the southern part of the area.

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The geology of the Knob Lake Group, Sims Formation and Shabogamo Gabbro in the map area has been previously described by Ware and Wardle (1979) and will not be repeated here. A considerable amount of new information has emerged regarding the stratigraphy and contact relationships of the Tamarack River Formation and is discussed below.

Tamarack River Formation

The Tamarack River Formation is a newly defined term (Ware and Wardle, 1979) for the poorly exposed sedimentary sequence which underlies the dominantly drift covered region between the Muriel outlier and Menihek Lake (Fig. 1). The formation is probably at least 300 m thick and consists of four informally defined members: an algal dolomite member, a lower red sandstone member, a green silstone member and an upper red sandstone member. The algal dolomite, lower sandstone and green siltstone members correspond to the previous three subdivisions of the formation recognized by Ware and Wardle (1979).

The formation is best exposed in three sections on the western flank of the Muriel outlier (Figure 1, Sections A, B, C). The upper part of Section A (Figure 2) is lithologically similar to the lower part of Section B and the upper part of Section B is, in turn, very similar to the lower part of Section C. On this basis, the three sections are considered to be in sequence and together define a type section for the formation. The possibility of lateral facies changes between the various sections cannot be completely ruled out but appears unlikely.

The lowest exposed lithology in the Tamarack River Formation is a 5 m thick unit of finely laminated green siltstone and mudstone with calcareous intercalations. This is overlain by a 20 m thick algal dolomite member which is composed of thickly bedded orange, red and brown algal dolomite interbedded with buff to maroon, microcrystalline dolomite. The member is characterized by an abundance of algal pisoliths and oncolites with minor digitate stromatolites.

Abruptly overlying the algal dolomite is a 20 m thick lower red sandstone member which consists mainly of arkosic sandstone with minor interbeds of granule conglomerate, red siltstone and intraformational mud chip conglomerate. Clast lithologies in the granule conglomerate include quartz, red chert, iron formation, orthoquartzite and mafic volcanic, all apparently derived from the Knob Lake Group. Sedimentary structures in the member include ripples, planar, trough and herring bone crossbedding, flaser and lenticular bedding and parallel lamination.

The lower red sandstone member fines gradually upward into the green siltstone member. This member, which is at least 150 m thick, is composed of thinly laminated and rippled green, brown and red siltstone and mudstone containing some interbeds of graded sandstone with load balls, flame structures and mud chip conglomerates.

This member gradually coarsens upwards into the 200 m thick upper red sandstone member which comprises fine to medium grained feldspathic sandstone with abundant detrital mica, thin laminations of red mudstone and calcareous mudstone intercalations. The lower parts of the member are characterized by mudcracks, mud chip conglomerates, parallel lamination, convoluted bedding, ripples and medium scaled (less than .75 m thick) planar and trough crossbedding. The upper part of the member is dominated by large scale (up to 2 m thick) planar-tabular crossbedding and medium scaled trough crossbedding.

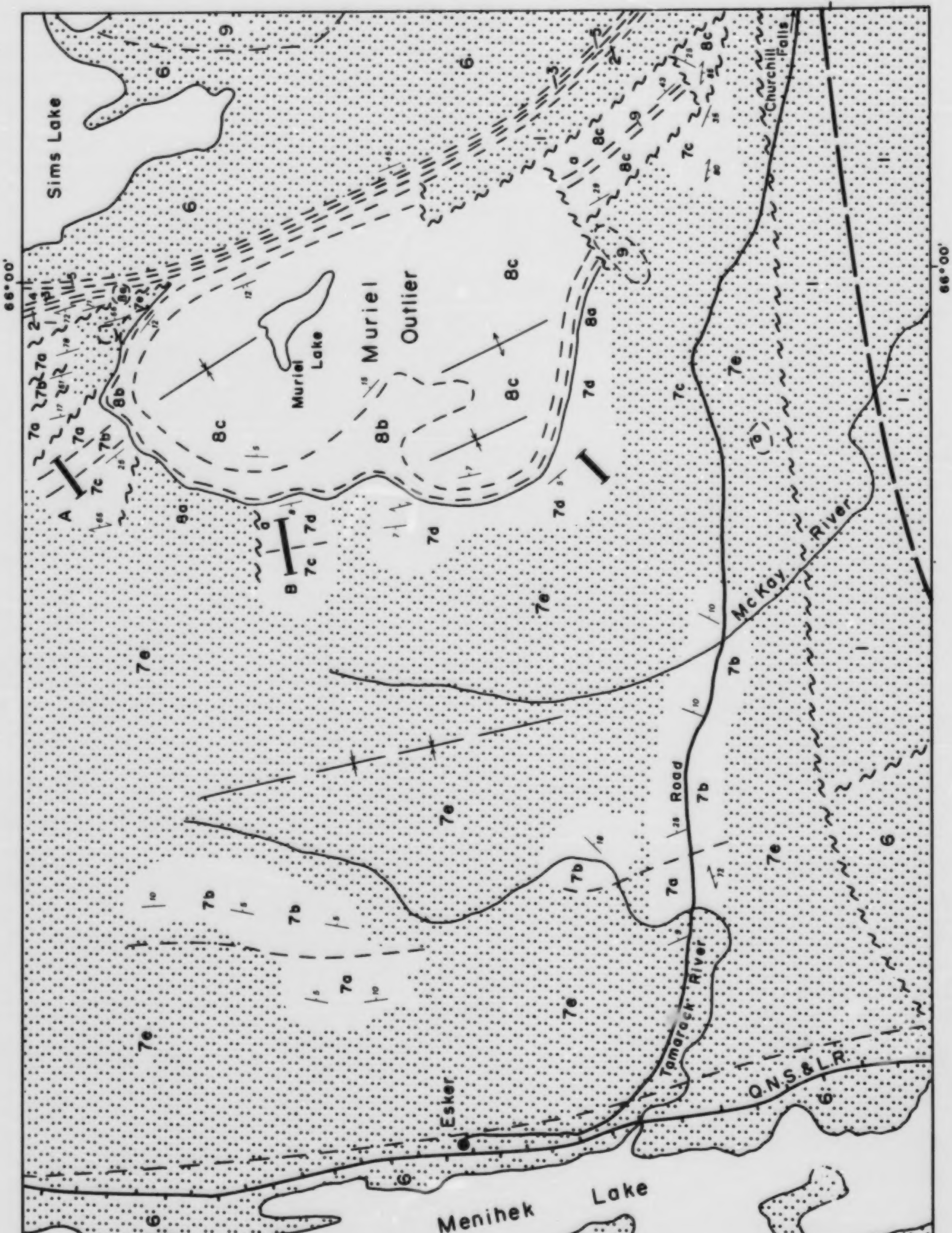
Paleocurrents measured in the upper red sandstone member indicate the existence of an easterly dipping

LEGEND

9	Shabogamo Gabbro:		Mafic intrusive.
8	Sims Formation:	8c,	Orthoquartzite;
		8b,	arkose;
		8a,	basal conglomerate.
7	Tamarack River Formation:	7e	Undifferentiated;
		7d	upper red sandstone;
		7c	green siltstone;
		7b	lower red sandstone;
		7a	algal dolomite.
Knob Lake Group			
6	Menihek Formation:		Argillite, graywacke, and slate.
5	Sokoman Formation:		Iron Formation.
4	Nimish Subgroup:		Mafic volcanics.
3	Wishart Formation:		Feldspathic sandstone.
2	Denault Formation:		Carbonate.
1	Attikmagen Formation:		Argillite, graywacke and slate.

SYMBOLS

Location of measured stratigraphic section.	╱
Approximate northern limit of Grenvillian deformation.	╱╱
Drift covered.	⁘



Sims Lake
Muriel Lake
Muriel Outlier
Churchill Falls
McKay River
Road
Tamarack River
Esker
Q.N.S.&L.R.
Menihek Lake
N
A
B
6
7a
7b
7c
7d
7e
8a
8b
8c
9
66°00'
66°30'
53°45'

TAMARACK RIVER FORMATION STRATIGRAPHY

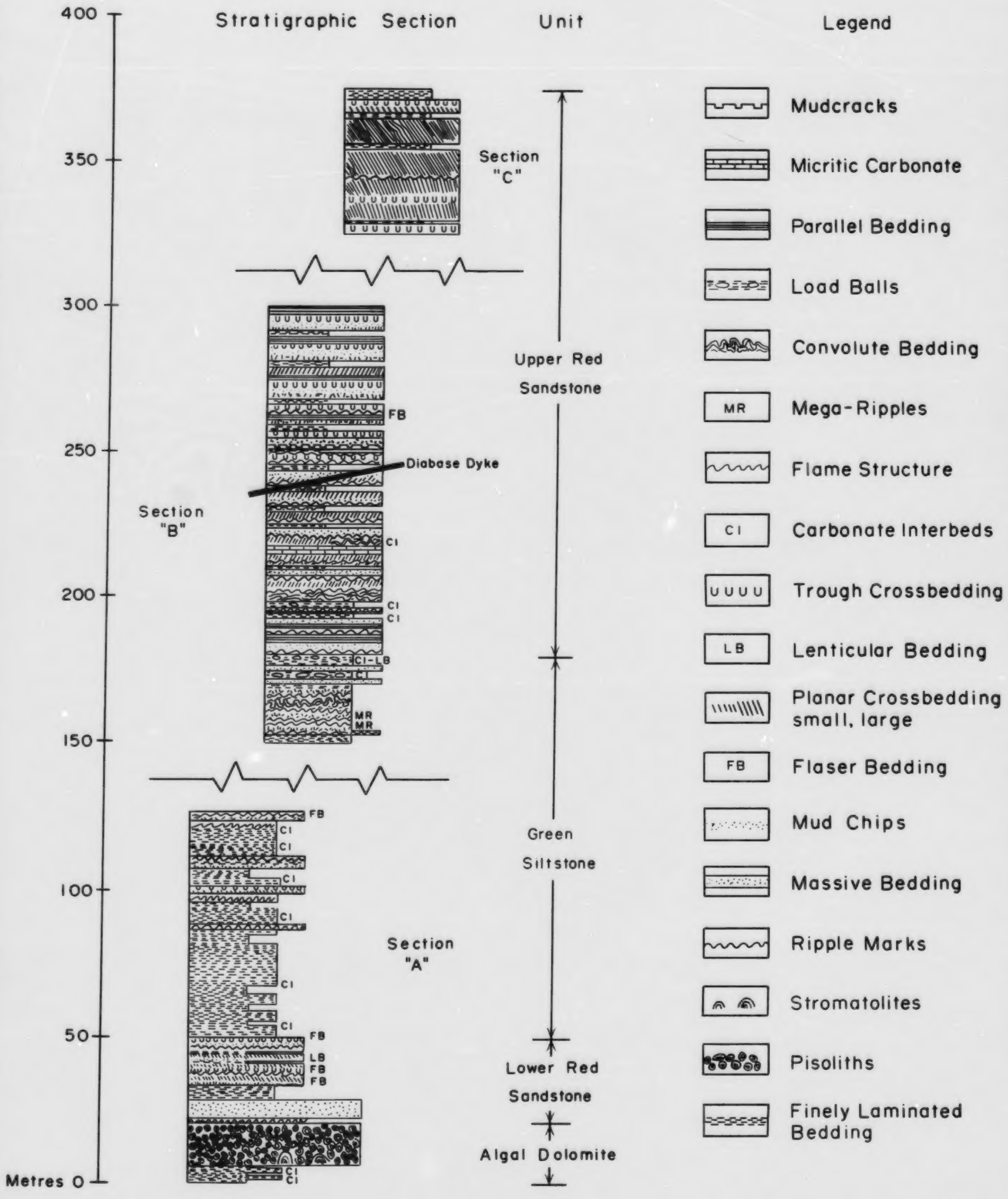

Stratigraphic Section
Unit
Legend
400
350
300
250
200
150
100
50
Metres 0
Section "C"
Section "B"
Section "A"
FB
Diabase Dyke
CI
CI
CI
CI-LB
CI
MR
MR
FB
CI
CI
CI
CI
CI
CI
FB
LB
FB
FB
CI
CI
Upper Red Sandstone
Green Siltstone
Lower Red Sandstone
Algal Dolomite
Mudcracks
Micritic Carbonate
Parallel Bedding
Load Balls
Convolute Bedding
MR
Mega-Ripples
Flame Structure
CI
Carbonate Interbeds
UUUU
Trough Crossbedding
LB
Lenticular Bedding
Planar Crossbedding small, large
FB
Flaser Bedding
Mud Chips
Massive Bedding
Ripple Marks
Stromatolites
Pisoliths
Finely Laminated Bedding

Figure 2

paleoslope during deposition of this part of the Tamarack River Formation.

Contact Relationships

The basal contact of the Tamarack River Formation is nowhere exposed, but the formation is thought to rest unconformably upon the Knob Lake Group (Ware and Wardle, 1979). Evidence for this assumption comes from the algal dolomite and arkose members of the formation which contain numerous clasts of typical Knob Lake Group lithologies (*i.e.* iron formation and red chert from the Sokoman Formation, quartzite from the Wishart Formation and mafic volcanics from the Nimish Subgroup).

The outcrop pattern of the Tamarack River Formation also suggests that it oversteps the Attikamagen and Menihek formations. However, the poor exposure and general similarity of Attikamagen and Menihek lithologies makes it very difficult to decide where the fault contact between the two units lies. It is conceivable, therefore, that the Tamarack River Formation could rest entirely on either the Menihek or Attikamagen formations.

The upper contact with the Sims Formation is an angular unconformity which was initiallly recognized by Ware and Wardle, (1979). This relationship has been further demonstrated in the area immediately northeast of the Muriel outlier where two small outliers, less than 0.5 km^2 in area, were recently found overlying cleaved and folded Tamarack River Formation strata.

The eastern contact of the Tamarack River Formation is in part a fault against the Knob Lake Group and in part an unconformity with the overlying Sims Formation. The southern contact of the formation with the Knob Lake Group is interpreted to be a fault produced during Grenvillian deformation. The northern and western limits are poorly defined. The northern boundary may extend a considerable distance north of the map area to include red siltstones located about 15 km north of Esker and mapped by Mauffette (1951) as part of the Menihek Formation.

STRUCTURE

The Knob Lake Group, Tamarack River Formation, and Sims Formation north of the Grenville Front have all been deformed, to varying extents, into northwesterly trending structures.

The Knob Lake Group and Tamarack River Formation in the western part of the map area (Figure 1) have gentle easterly dips and are only moderately cleaved. Structural complexity increases to the east so that in the area northeast of the Muriel outlier both units have steep bedding attitudes, are cleaved, and have been affected by numerous, small, high angle faults.

The Sims Formation is gently folded about northwesterly trends but does not possess a cleavage.

In the previous mapping in the area (Ware and Wardle, 1979), it was proposed that the major stratigraphic break in the area lay between Tamarack River Formation and Knob Lake Group and that this corresponded to the Hudsonian Orogeny. However, the more recent detailed mapping around the Muriel outlier has shown that in its eastern extremities the Tamarack River Formation is strongly cleaved and apparently has been deformed together with the Knob Lake Group. These two units are overlain by two small outliers of undeformed, flat lying Sims Formation. It is evident from this later relationship that the major stratigraphic break in the area, i.e. the Hudsonian Orogeny, occurs between the Tamarack River and Sims Formations. On this basis, the age of the Tamarack River Formation must be redefined as late Aphebian rather than Paleohelikian as suggested by Ware and Wardle (1979).

The unconformity between the Knob Lake Group and Tamarack River Formation is probably the result of minor disturbance and uplift in the Labrador Trough prior to the Hudsonian Orogeny.

The gentle folds in the Sims Formation may be attributed either to drap over pre-existing structures, or to a weak residual pulse of the Hudsonian Orogeny.

The southern exposures of the Tamarack River Formation have been affected by the local development of an east-west trending fracture cleavage which is interpreted to be the result of Grenvillian (circa, 1000 Ma) deformation, and to mark the most northerly development of penetrative Grenvillian structures in western Labrador.

ECONOMIC GEOLOGY

The major potential of the Tamarack River and Sims Formations continues to be for uranium mineralization (Ware and Wardle, 1979). Both the probable unconformity at the base of the Tamarack River Formation and the unconformity at the base of the Sims Formation offer potential exploration targets for epigenetic mineralization.

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GEOLOGICAL MAPPING IN THE EVENING LAKE - WIGHTMAN LAKE AREA, WESTERN LABRADOR

by

T. Rivers

INTRODUCTION

1:100,000 scale mapping of the Evening Lake (23G/9), Molson Lake (23G/8), Wightman Lake (23G/1) and the northern part of Lac Petite - Hermine (23B/16) N.T.S. areas was completed during the summer. The Molson Lake and Wightman Lake map areas are due east of the area mapped in 1978.

Exposure varies from poor in many of the low lying parts of the area, to good on the tops of many of the hills which area capped with gabbro. Critical contact relationships are rarely exposed, however, and most of the unit boundaries have to be interpreted with the use of air photographs and aeromagnetic maps.

General Geology

Rocks in the Knob Lake Group of the Labrador Trough (Churchill Province) continue south of the Grenville Front into the Grenville Province where they are known as the Gagnon Group. In the Churchill Province the grade of metamorphism in the Knob Lake Group is typically low (subgreenschist facies) and the rocks possess a single tectonic fabric; in the Grenville Province the prevailing grade of metamorphism is higher (amphibolite facies) and the rocks exhibit the effects of polyphase deformation. The two tectonic provinces are separated by the Grenville Front, a region which is defined by east-west tectonic fabrics and by a series of thrust faults, and south of which there is an abrupt rise in metamorphic grade. The Grenville Front therefore marks the northerly limit of structures developed during the Grenvillian orogeny - it is a tectonic feature unrelated to the age or metamorphic grade of the rocks included within the Grenville Province.

Previous Work

One inch to 1/2 mile mapping by Iron Ore Company of Canada (Baird, 1950) covers part of the Evening Lake sheet, as does a thesis by Goodwin (1951). This was followed by detailed mapping in areas of iron formation outcrop, including the work of Beemer (1952) and Frazer (1952). Mapping by the Newfoundland and Labrador Corporation (Magnusson, 1953) covers much of the southern half of the map area. The Sims Formation was mapped by the Newfoundland Department of Mines and Energy (Ware, 1979), and the whole area is covered by the Geological Survey of Canada maps of Fahrig (1967) and Jackson (1976). In this work the Sims Formation is compiled directly from Ware (1979).

Objectives

The objectives of the mapping project were:-

(1) To trace out the iron formation and associated units of the Gagnon Group in the Grenville Front region.

(2) To investigate the nature of the Grenville Front.

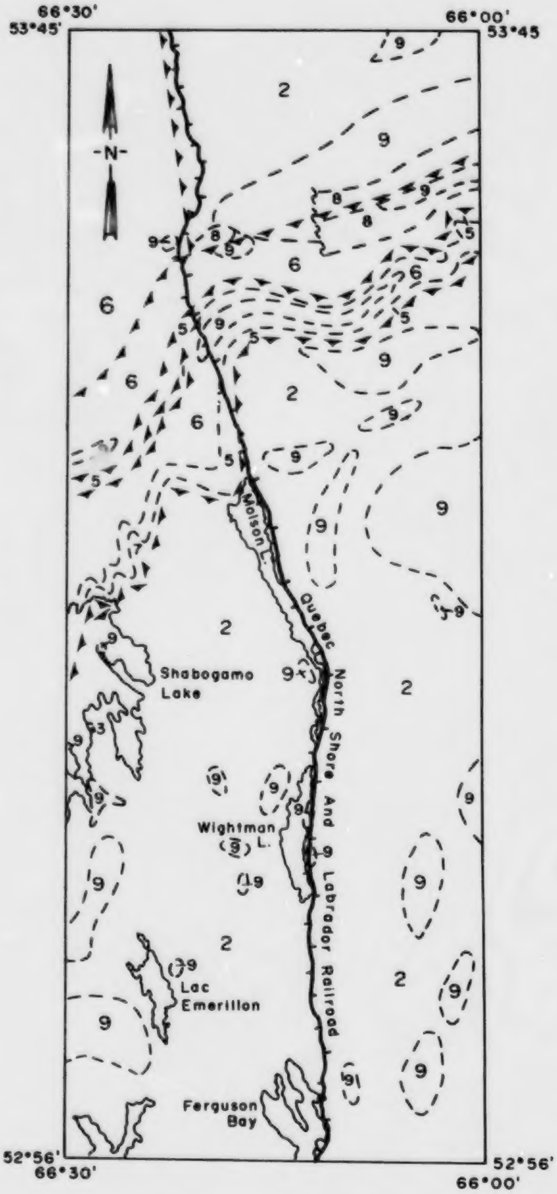
(3) To map the extent of the Gagnon Group in the southern part of the map area, and in particular to investigate the possibility of basement - cover relationships in that area.

(4) To assess the mineral potential of the area.

LEGEND

Helikian	
9	Shabogamo Gabbro: Metagabbro and amphibolite
8	Sims Formation: Quartzite
Aphebian	
Gagnon Group	
7	amphibolite - metatuff?
6	Nault Formation: Gray phyllite and schist
5	Wabush Formation: Iron formation
3	Duley Formation: Dolomitic marble
2	Katsao Formation: Metagraywacke/slate (north of Grenville Front) quartzofeldspathic schist (south of Grenville Front)
Archean	
1	Ashuanipi Complex: Banded migmatitic gneisses.

NOTE: Unit 8 is compiled from Ware (1978).


66°30'
53°45'
66°00'
53°45
-N-
Molson L.
Quebec North Shore And Labrador Railroad
Shabogamo Lake
Wightman L.
Lac Emerillon
Ferguson Bay
52°56'
66°30'
52°56'
66°00'
2
9
8
6
5
7
3

DESCRIPTION OF UNITS

Ashuanipi Complex - Unit 1

Gneisses of the Ashuanipi Complex outcrop in a small area in the Grenville Front region, where they are interpreted to be in fault contact with the adjacent rocks of the Gagnon Group. The gneisses appear similar to those mapped in the main body of the Ashuanipi Complex to the west (Rivers and Massey, 1979), being predominantly composed of coarse grained rocks of granodioritic composition, with an irregularly developed, coarse fracture cleavage of presumed Grenvillian age superimposed on the gneissosity. The most common mafic minerals in the gneisses are biotite and actinolite, the latter probably pseudomorphous after pyroxene.

Katsao Formation - Unit 2

The Katsao Formation in the Grenville Province and the equivalent Attikamagen Formation of the Churchill Province outcrop extensively in the map area. In the Churchill Province the Attikamagen Formation is a banded graywacke/shale sequence with sedimentary structures such as crossbedding, load structures and graded bedding (poorly developed) seen in a few places.

In the Grenville Province all evidence of primary structures is generally obliterated, and the rock is a quartz-feldspar-biotite schist/gneiss ± garnet ± hornblende ± muscovite ± K. feldspar ± kyanite ± sillimanite. The texture of the rock varies from coarse to fine grained, and feldspar augen are common in the Grenville Front region. Some of the finer grained specimens are almost mylonitic in aspect and may have undergone high strains.

In the southern part of the map area, a massive, fine grained rock of similar composition to the Katsao Formation, but which may be igneous in origin, was mapped. This has been provisionally included within the Katsao Formation pending the results of further work.

Duley Formation - Unit 3

The Duley Formation (Unit 3), was observed at only one location, on the shore of Shabogamo Lake in the western part of the map area. There, a small band of dolomitic marble about 2 m wide occurs within schists of the Katsao Formation. Although the lithology is typical of the Duley Formation to the west (Rivers, 1978; Rivers and Massey, 1979), it is uncertain whether this outcrop represents an infolded keel of Duley Formation proper, or a small lens of similar lithology within the Katsao Formation.

In the Wabush area, quartzite overlies the marble, but this unit was not observed in the Evening Lake - Wightman Lake area.

Wabush Formation - Unit 5

The Wabush Formation consists of iron formation and associated lithologies. Silicate carbonate facies iron formation is predominant, being composed of quartz, grunerite, and iron carbonate (siderite ± Fe dolomite ± ankerite). Locally a two amphibole (grunerite and hornblende/actinolite), garnet iron formation also occurs, with the green amphibole and garnet possibly being due to tuffaceous imput into the unit (see Noel and Rivers, this volume).

Nault Formation - Unit 6

The Nault Formation in the Grenville Province, and its unmetamorphosed equivalent, the Menihek Formation in the Churchill Province, outcrops in the northern part of the map area. The typical lithology is a gray to black phyllite, slate or shale depending upon metamorphic grade, which is generally devoid of sedimentary structures. In the Grenville Front region this rock is well foliated, and may show evidence of more than one phase of tectonic structures.

Amphibolite - Unit 7

Amphibolite, which may represent tuffaceous or reworked tuffaceous rocks, occurs in the Grenville Front region in two localities, in association with the Wabush and Nault Formations. The predominant mineralogy is actinolite, with chlorite and hornblende? also being present. Disseminated sulphides (mainly pyrite) are common.

Sims Formation - Unit 8

White-pink massive orthoquartzite and fine grained conglomerate compose this unit, which lies unconformably on the rocks of the Gagnon Group in the Grenville Front region. Detailed descriptions of the Sims Formation may be found in Ware (1979).

Shabogamo Gabbro - Unit 9

This unit, which includes gabbro and leucogabbro and their metamorphosed equivalents, amphibolite and actinolite schist, intrudes members of the Gagnon Group and the Sims Formation. Relict igneous textures are common in the gabbro, generally with signs of metamorphic overgrowth or replacement superposed on them. In the northern part of the map area the mafic minerals of the gabbro are typically replaced by actinolite, whereas to the south they are commonly surrounded or replaced by composite coronas of actinolite, garnet, biotite and hornblende.

The large body of gabbro in the eastern part of the map area is part of an intrusive complex containing several magma types including megacrystic leucogabbro, fine grained gabbro and the more normal leucogabbro described above. With the exception of this complex around which the country rocks are warped, most of the intrusions are concordant sill-like structures which were deformed with the surrounding metasedimentary envelope.

STRUCTURAL GEOLOGY

The thrust fault zone of the Grenville Front region divides the area naturally into two parts. North of the thrust faults the rocks possess a single tectonic fabric (slaty cleavage), typically with east-northeast trends. This fabric is interpreted to be of Grenvillian age, so the northerly limit of the Grenville Front region, and thus the southern boundary of the Churchill Province, may lie in the extreme north of the map area. Exposure is poor and the exact location is speculative.

South of the thrust zone, most rocks display evidence of at least two phases of deformation, and it is likely that the area as a whole has been affected by three deformation episodes. East-northeast trending structures in the Grenville Front region predate northwest trending structures in the southerly part of the map area.

METAMORPHISM

North of the thrust fault zone, metamorphic grade is in the sub-greenschist facies; south of the thrust fault zone mineralogies characteristic of the amphibolite facies predominate. There appears to be a significant telescoping of the metamorphic gradient at the most southerly thrust fault. Kyanite occurs in the schists in the central part of the map area, whereas sillimanite is present in the southeast, suggesting a transition from middle to upper amphibolite facies assemblages in that region.

ECONOMIC GEOLOGY

No showings of economic significance were seen in the area. Iron formation is predominantly of the silicate carbonate facies, which is not of commercial interest. Disseminated pyrite in the amphibolite unit and disseminated magnetite in gabbro typically occur in small showings with little potential for enlargement.

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GEOLOGICAL MAPPING IN THE WABUSH LAKE AREA, SOUTHWESTERN LABRADOR

by

T. Rivers

INTRODUCTION

Mapping was carried out during the summer on parts of N.T.S. areas 23B/10, 23B/14, 23B/15, 23G/2 and 23G/3, and the area between Wabush Lake and the Quebec border is now covered. The work involved completion of two map areas (23B/15 and 23G/2) and checking the detailed maps of Iron Ore Company of Canada and Newfoundland and Labrador Corporation in the remaining parts of the area. The detailed mapping was found to be generally good, and few changes were made in the designation of units. The interpretation, however, is substantially different in places.

General Geology

The area spans two tectonic provinces, the Superior Province and the Grenville Province. The border between the two, known as the Grenville Front, is marked by a series of thrust faults in the Wabush area (see also Rivers & Massey, 1979), and also by cataclastic fabrics imposed on the older rocks immediately northwest of the thrust faults. The Grenville Front, therefore, marks the northerly limit of deformation imposed during the Grenvillian Orogeny, and is unrelated to the age, structural state or metamorphic grade of the rocks included within the Grenville Province to the south.

North of the Grenville Front, gneisses and igneous rocks of the Ashuanipi Complex form a basement upon which the metasedimentary Gagnon Group of Aphebian age was deposited. Rocks of the Gagnon Group outcrop extensively south of the Grenville Front and comprise a distinctive succession of schist, marble, quartzite, iron formation and schist respectively in decreasing age. The two schist units are frequently difficult to distinguish on the basis of lithology, but the succession marble-quartzite-iron formation permits a younging direction to be established in certain areas.

Evidence of three distinct phases of deformation can be found in rocks of the Gagnon Group, all of which were probably part of the Grenvillian Orogeny which took place about 1,000 Ma ago. Metamorphic grade during the Grenvillian Orogeny varied from greenschist grade near the Grenville Front to amphibolite grade in the southeastern part of the area.

Previous Work

1 inch to 1/2 mile mapping by Iron Ore Company of Canada (Neale, 1951) and by Newfoundland and Labrador Corporation (Boyko, 1953) outlined the general geology of most of the area. Subsequently, during the 1950's geologists of Iron Ore Company and Labrador Mining and Exploration Company carried out 1 inch to 1,000 foot scale mapping in areas of iron formation outcrop. Ph.D. theses by Jackson (1962) and Knowles (1967) include part of the area, and the whole area is covered by the Geological Survey of Canada maps of Stevenson (1964) and Jackson (1976). Much detailed geological information is available around the open pit iron ore mines operated by Iron Ore Company and Wabush Mines, and a third mining operation at Mount Wright in Quebec is located a few kilometres southwest of the mapped area. That part of the area adjacent to Wabush Lake was mapped at the beginning of the project during 1977 (Rivers, 1978 a, b), and part of the

northeastern corner of the map area was completed during 1978 (Rivers and Massey, 1979).

Objectives

The objectives of the mapping project were to:

(a) evaluate the existing map coverage of the area and determine if it could be used as a basis for compilation;

(b) investigate the structural geometry of the Gagnon Group;

(c) investigate the nature of the Grenville Front;

(d) assess the economic potential of the area;

(e) to collect samples for $^{40}Ar/^{39}Ar$ radiometric dating in the region of the Grenville Front in order to investigate the nature of that important, but poorly understood, boundary. This project was started in 1978 (see Rivers and Massey, 1979), and the intention this year was to fill in gaps in the 1978 sample distribution.

DESCRIPTION OF UNITS

Ashuanipi Complex - Unit 1

Two distinctive lithologies comprise the Ashuanipi Complex in the map area. In the northwestern part of the area, the unit is composed of a banded migmatitic gneiss of granodioritic to dioritic composition, similar to that mapped during 1978 (Rivers & Massey, 1979). Bands, lenses and boudins of foliated dioritic gneiss are typically surrounded by granodioritic to granitic rocks with igneous textures. Pyroxenes are present in both phases of the migmatite.

Provisionally included in the Ashuanipi Complex, although younger than the Archean gneisses described above, is a massive, coarse grained, white alaskitic granite. Relationships between the gneisses and the granite are not seen, but the granite presumably intrudes the gneisses and is post-Kenoran in age. Both the granite and the gneisses are cut by a coarse cataclastic fabric of Grenvillian age in the Grenville Front region, which provides an upper limit on the age of intrusion of the granite.

Unit 2 - Katsao Formation

The lowest unit of the Aphebian Gagnon Group, the Katsao Formation is composed of a massive to banded biotite bearing quartzofeldspathic schist ± hornblende, garnet, muscovite, kyanite and K-feldsar. It is typically a medium to coarse grained rock with a well developed foliation defined by biotite. Concordant migmatitic veining occurs locally, and near the thrust faults in the Grenville Front region, feldspar augen are common and the rock is a porphyroclastic augen schist.

Unit 3 - Duley Formation

Buff to black weathering marble with quartz veins constitutes the Duley Formation, which conformably overlies the Katsao Formation in part of the area. It is present as an extensive unit in the central part of the area, but apparently wedges out laterally to the east and west over a distance of 5-10 km. Dolomite typically predominates over calcite; tremolite and diopside are common, and quartz may compose over 75% of the rock in some places.

Unit 4 - Wapussakatoo Formation

Coarse grained massive quartzite and subordinate quartz-muscovite schist compose this unit, which outcrops on many of the high hills west and southwest of Wabush lake. The Wapussakatoo Formation locally overlies the Duley Formation, but west of the outcrop of the latter unit, it lies directly on the Katsao Formation, possibly unconformably as is seen in the Labrador Trough to the north, *e.g.* Wardle and Doherty, 1978.

LEGEND

HELIKIAN

8 Shabogamo gabbro: Metagabbro and amphibolite

APHEBIAN

7 Amphibolite: Metatuffs (?)

GAGNON GROUP

6 Nault Formation: Quartzofeldspathic schists and gneisses

5 Wabush Formation: Iron Formation

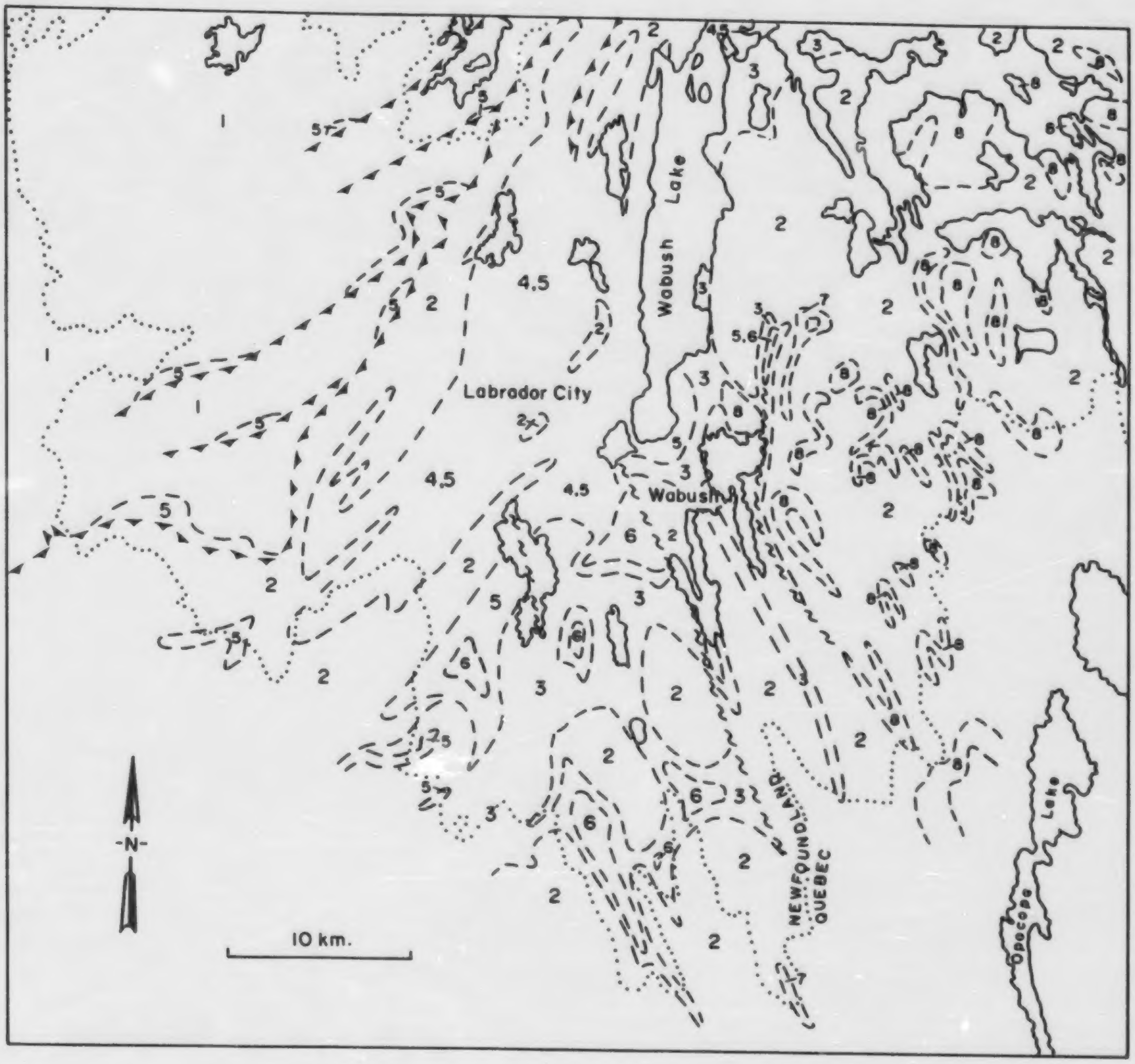
4 Wapussakatoo Formation: Quartzite

3 Duley Formation: Marble

2 Katsao Formation: Quartzofeldspathic schists and gneisses

ARCHEAN

1 Ashuanipi Complex: Banded migmatitic gneiss and intrusive granitoid rocks.


Wabush Lake
Labrador City
Wabush
NEWFOUNDLAND
QUEBEC
Opocopa Lake
-N-
10 km.

On the accompanying sketch map, the Wapussakatoo Formation has been included with the overlying Wabush Formation to simplify the map pattern.

Unit 5 - Wabush Formation

Iron formation and associated rocks constitute the Wabush Formation. The following lithologies compose most of this unit: - (a) silicate-carbonate iron formation, consisting of quartz, Fe carbonate (siderite, ankerite or Fe dolomite), grunerite, hedenbergite, magnetite; (b) ferruginous quartzite; (c) tuffaceous iron formation, composed of quartz, Fe carbonate, grunerite, hornblende/actinolite and garnet; (d) oxide iron formation composed of hematite, quartz and magnetite. Oxide iron formation is the lithology upon which the mining industry is based, and it occurs in large deposits in the belt west and southwest of Wabush Lake.

Unit 6 - Nault Formation

The Nault Formation conformably overlies the Wabush Formation. In the north of the area, small outcrops of this unit (not on map) are composed of a distinctive black graphitic schist. However, further south, where the metamorphic grade is higher, graphite is not present, or is present only as grain coatings, and the unit is a quartz-feldspar-biotite schist, very similar in appearance to the Katsao Formation.

Unit 7 - Amphibolite

Coarse grained, massive, highly garnetiferous amphibolite occurs in several locations within the Katsao Formation. It appears to be a distinct lithology unrelated to the Shabogamo Gabbro (see below) which typically has considerably more plagioclase feldspar. The origin of the unit is speculative, but it may be a metavolcanic rock of some sort, possibly a metatuff.

Unit 8 - Shabogamo Gabbro

The Shabogamo Gabbro is predominantly composed of leucogabbro and its metamorphosed equivalents, coronitic metagabbro, amphibolite and mafic biotite schist. This unit outcrops extensively within the Katsao Formation in the east of the map area, mostly in the form of sills concordant with the foliation in the schist. West of Wabush Lake, sills of gabbro intrude a variety of units, but they are too small to appear on the accompanying sketch map. Throughout the area there is considerable textural variation within the gabbro, with medium and coarse grained phases occurring in the same intrusion, and very coarse grained pegmatitic phases being encountered in several locations.

STRUCTURAL GEOLOGY

In the migmatitic gneisses of the Ashuanipi Complex there is evidence of two periods of deformation of presumed Kenoran age (about 2,600 Ma ago).

Rocks of the Gagnon Group have been affected by three distinct episodes of deformation of Grenvillian age (about 1,000 Ma ago). During the first of these, they were thrust up against the Ashuanipi Complex, and deformed into tight, recumbent, intrafolial folds, generally of small amplitude. A penetrative axial planar foliation was developed in most lithologies, and a coarse cataclastic fabric was developed in the adjacent portions of the Ashuanipi Complex in the Grenville Front region.

Folds of the second generation are northeast trending, gently plunging structures, overturned towards the northwest (*i.e.* the basement). The latest phase of folds to develop were northwest trending features, formed at high angles to the preceeding structures. D1 and D2 structures dominate the map pattern near the Grenville Front and D3 trends are predominant in the interior Grenville Province in the southeast part of the map area. South of Wabush Lake, interference of D2 and D3 structures has given rise to a dome and basin interference pattern.

METAMORPHISM

The quartzofeldspathic gneisses of the Ashuanipi Complex contain pyroxenes, indicating that metamorphism during the Kenoran Orogeny attained upper amphibolite or granulite facies.

Metamorphism of rocks of the Gagnon Group took place during the Grenvillian Orogeny. Near the thrust faults, metamorphic grade is in upper greenschist facies, and it rises to upper amphibolite facies towards the southeast. Kyanite is locally common in schists of the Katsao and Nault Formations throughout much of the area; tremolite and diopside occur in the Duley Formation, and minerals such as grunerite-cummingtonite, hedenbergite and eulite-orthoferrosilite occur in silicate carbonate iron formation. Composite metamorphic coronas around primary olivine, pyroxene and opaques are common in the Shabogamo Gabbro, and typically consist of actinolite ± garnet ± biotite. In gabbro samples with little igneous texture remaining, hornblende is the dominant mafic mineral.

ECONOMIC GEOLOGY

Vast deposits of oxide iron formation occur west and south of Wabush Lake, and these provide the basis for three mining operations in the region. Several more deposits of suitable tonnage and grade exist for possible future developments.

There are few other mineral showings of interest. Disseminated magnetite in gabbros and sulphides in marble are unlikely to be economic.

Possible materials for industrial use include the quartzite of the Wapussakatoo Formation, which assays over 99.5% SiO_2 in analysed samples. Kyanite in the Katsao and Nault Formations, however, is probably too disseminated to be of commercial value.

ACKNOWLEDGEMENTS

I would like to thank Michael Clarke for running some of the traverses in the area, and Helen Norman and David Evans for their enthusiastic assistance throughout the season. Flying services were provided by Ashuanipi Aviation, Universal Helicopters and Golfe Helicopters. Wayne and E.J. Tuttle provided logistical back up service during the project. A visit by Paul Williams of Leiden University, Netherlands, was enjoyed by all the party, and his help with traversing is much appreciated. Discussions with Paul Williams and David Dallmeyer during the course of the field season were very stimulating.

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REVISED NOMENCLATURE FOR APHEBIAN AND OTHER ROCKS, SOUTHERN LABRADOR TROUGH, GRENVILLE PROVINCE

by
T. Rivers

Stratigraphically equivalent Aphebian rocks occurring within The Churchill and Grenville Provinces have different group and formation names. The names for the Churchill Province have precedence, and in order to avoid unnecessary proliferation of nomenclature it is proposed to drop the equivalent names in the Grenville Province. Specifically, it is proposed that the term Knob Lake Group be used in place of Gagnon Group, and that the formational names of the Gagnon Group be replaced by those of the Knob Lake Group as follows: - Katsao, Duly, Felix, Wapussakatoo (or Carol), Huguette, Wabush and Nault Formations to be replaced by Attikamagen, Denault, Dolly, Wishart, Ruth, Sokoman and Menihek Formations respectively.

For the Helikian rocks known variously as Shabogamo Gabbro, Shabogamo Intrusions, Shabogamo Group or Shabogamo Formation, the term Shabogamo Intrusive Suite is proposed, in accordance with the newly revised stratigraphic code. Similarly, following the new nomenclature it is suggested that the Archean basement terrain known as the Ashuanipi Complex be renamed the Ashuanipi Metamorphic Complex.

(This is the abstract of a short paper submitted to the Canadian Journal of Earth Sciences. Although not used in this Report of Activities, the terminology proposed in the paper will be used in all future publications by the Department.)

GEOLOGICAL MAPPING IN THE MCKAY RIVER - GABBRO LAKE AREA, WESTERN LABRADOR

by

N. Noel and T. Rivers

INTRODUCTION

The McKay River area (N.T.S. 23H/12) and the western half of the Gabbro Lake area (N.T.S. 23H/11) were mapped during the summer, thus completing coverage of iron formation and associated lithologies of the Gagnon Group in the Grenville Front region. Ground traversing was mainly restricted to the central part of the McKay River area, where outcrop is abundant. Most of the peripheral areas were mapped by helicopter and there is only a sparse outcrop distribution upon which to base interpretation.

General Geology

The map area is located at the southeastern end of the Labrador Trough near the boundary with the Grenville Province, and the whole area lies in the Grenville Front Tectonic Zone. Most of the lithologies of the Gagnon Group* are present in the area (with the exception of quartzite), and the stratigraphy also includes basic to intermediate volcanic rocks and volcanogenic sediments possibly equivalent to the Nimish Subgroup (Evans, 1978). Felsic volcanic rocks and associated volcanogenic sediments, considered to be a separate group (Blueberry Lake group) from the basic volcanics (Wardle, 1979a, b), occur in the eastern part of the map area.

In the northern third of the area, structural trends are northwest and reflect the Hudsonian Orogen; in the southern part of the area most structures strike approximately east-west and are of Grenvillian age. In the McKay River area, as elsewhere along its length (Rivers and Massey, 1979; Rivers, this volume), the Grenville Front is interpreted to be a region of thrust faulting in which rocks of the Grenville Province were overthrust onto rocks of the adjacent, older tectonic province to the north.

Previous Work

The first maps of the area were produced by Iron Ore Company of Canda (Baird, 1950) and Labrador Mining and Exploration Company (Beland, 1950) at 1 inch to 1/2 mile scale, and these were followed by the more detailed work of Tiphane (1951), Jackson (1952), Frazer (1952), Peach (1952) and Slipp (1952). Later regional mapping by the Geological Survey of Canada covered the whole map area (Wynne-Edwards, 1961). Various aspects of the geology have been considered in some detail in the theses of Goodwin (1951), Badhroom (1961), Giovanella (1961) and Henderson (1965).

Mapping of the Sims Formation was carried out by the Newfoundland Department of Mines and Energy (Ware, 1979; Ware and Wardle, 1979) and has been compiled directly in this project. The Blueberry Lake group in the Gabbro Lake area was the object of some detailed mapping by the Newfoundland Department of Mines and Energy (Wardle, 1979a, b), and this too has been compiled in the present project.

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*Previous Workers (*e.g.* geologists of Iron Ore Company of Canada, Wynne-Edwards, 1961; Wardle, 1979) assigned the Aphebian rocks in the area to the Knob Lake Group. Gagnon Group is the name given to the metamorphosed equivalents of the Knob Lake Group within the Grenville Province.

Objectives

It was hoped that the mapping would shed some light on the following problems:

(a) the nature and affinity of the basic to intermediate volcanic rocks, and in particular their relationship, if any, with the Wabush Formation;

(b) the nature of the Grenville Front;

(c) the relationship between the newly defined Blueberry Lake group (Wardle, 1979a, b), and the Gagnon Group;

(d) the structural configuration at the southeast end of the Labrador Trough, where Hudsonian and Grenvillian trends intersect; and

(e) to assess the mineral potential of the area.

DESCRIPTION OF UNITS

Unit 1 - Archean - granodiorite to tonalite gneiss

Although this unit outcrops extensively to the north where it is known as the Eastern Basement Complex (Wardle, 1979b), there are only a few outcrops in the map area. It is a white to gray orthogneiss consisting predominantly of quartz + plagioclase + biotite ± hornblende and K-feldspar, quite distinct from the banded gneisses of the Ashuanipi Complex described by Rivers and Massey (1979) and Rivers (this volume). Wardle (1979b) reports that some outcrops of this unit are situated within bodies of Shabogamo Gabbro and have the form of large rafts or inclusions.

Unit 2 - Katsao Formation

The oldest unit of the Gagnon Group, the Katsao Formation, outcrops both north and south of the thrust faults in the area. North of the thrust faults it is a banded graywacke/shale sequence with sedimentary structures such as crossbedding, vague graded bedding and load structures locally visible. A single tectonic fabric (slaty cleavage) is present.

In the southern part of the map area, the Katsao Formation appears as a quartz-feldspar-biotite schist ± hornblende, garnet, K-feldspar and muscovite. Textures vary from schistose to massive, with some examples displaying strongly developed cataclastic fabrics (augen schists and mylonites). In contrast to the Katsao Formation north of the thrust fault zone, these rocks have evidently undergone polyphase deformation.

Unit 3 - Duley Formation

This unit is typically composed of dolomitic marble as elsewhere in the Gagnon Group; locally calcite predominates over dolomite though, and layers and boudins of dolomitic marble occur in gray-black calcitic marble with minor graphite. Minor conglomeratic units are seen, in one place containing clasts of granite gneiss, similar to the Archean Ashuanipi Complex in the west (Rivers and Massey, 1979).

A significant difference between the Duley Formation in the McKay River - Gabbro Lake area and elsewhere in the Gagnon Group is the intimate associaton with chlorite schist (unit 4). A complete gradation between marble with minor chlorite schist fragments to chlorite schist with disseminated carbonate exists, and the units have been arbitrarily subdivided on the basis of the predominant lithology in any given outcrop.

Unit 4 - Chlorite schist and conglomerate - Nimish Subgroup?

Rocks of this unit are in close spatial association with the Duley Formation (see above) and the Wabush Formation (unit 6). Chlorite schists are typically medium grained rocks, dark green in colour and possessing disseminated carbonate in many outcrops. They may represent tuffs or reworked tuffaceous sediments.

LEGEND

HELIKIAN

10 Shabogamo Gabbro

9 Sims Formation: Orthoquartzite

APHEBIAN

8 Blueberry Lake group: Polymictic conglomerate, tuffaceous sandstone, slate.

Gagnon Group

7 Nault Formation: Gray phyllite

6 Wabush Formation: Silicate-carbonate iron formation, magnetite graywacke, tuffaceous magnetite iron formation.

Nimish Subgroup (?)

- 5 Basic volcanic rocks, including pillow lava.
- 4 Chlorite schist (metatuff) and chloritic conglomerate.

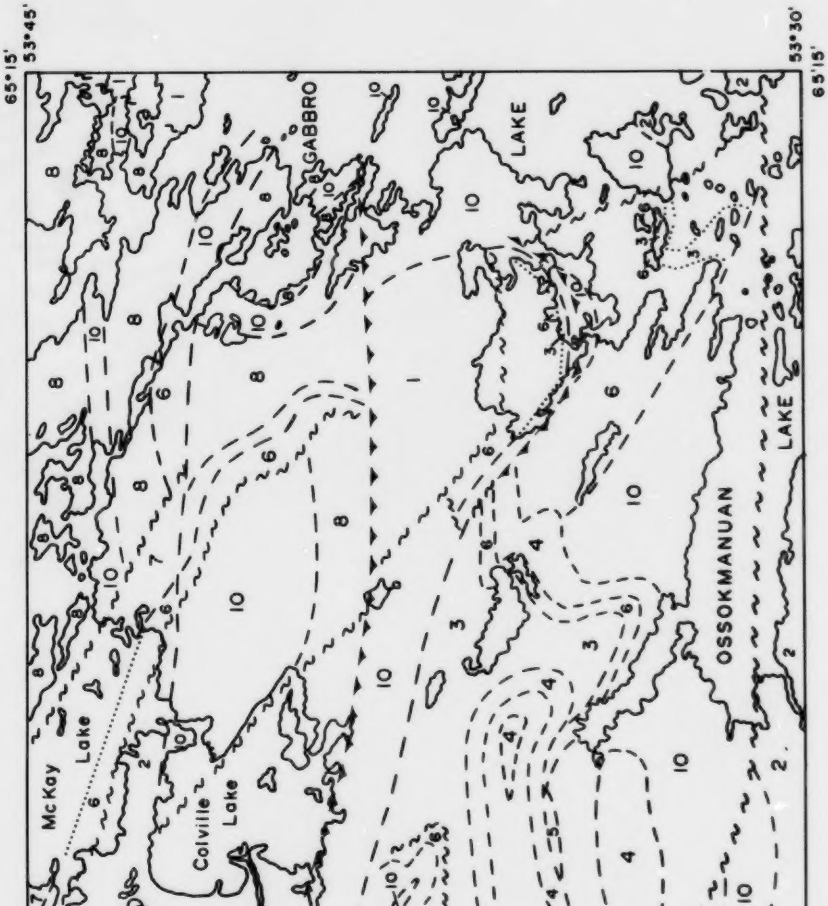
3 Duley Formation: Dolomitic marble

2 Katsao Formation: Graywacke/slate sequence (in north of map); quartzofeldspathic schist (in south of map)

ARCHEAN

1 Granodiorite to tonalite gneiss.

Note: (1) Much of the Blueberry Lake group compiled from Wardle (1978).
(2) Sims Formation compiled from Ware (1978)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LAKE

Chloritic conglomerates are intimately associated with the chlorite schists and the matrix of the conglomerate is composed of chlorite schist identical to that described above. Clasts in the conglomerate are composed principally of volcanic rocks (see unit 5), with minor amounts of fine grained sediment (slate) also being present in some outcrops. Disseminated pyrite mineralizaton is common throughout this unit and disseminated magnetite is restricted to the chlorite schists.

Unit 5 - Volcanic rocks - Nimish Subgroup?

Volcanic rocks, locally porphyritic, amygdaloidal and vesicular, and including pillow lavas, compose unit 5. These rocks vary from massive to schistose and contain chlorite and actinolite as the dominant mineralogy. In the pillow lavas, the interpillow area is commonly filled with calcite which may be primary, possibly indicating extrusion into the carbonate environments which existed during deposition of the Duley or Wabush Formations. Furthermore, the volcanic rocks appear to be the lateral equivalents of the iron formation in the southern part of the area, suggesting that they may represent a volcanic pile which locally replaced iron formation in the stratigraphy. Two outcrops of a crowded feldspar porphyry occur in association with iron formation in the eastern part of the map area; these may represent crystal-lithic tuffs or highly porphyritic lavas.

It is difficult to assess the chemical composition of these retrogressed rocks in the field, but it is likely that they lie in the basalt-andesite field.

On the basis of stratigraphic position, the volcanic and volcanogenic rocks of units 4 and 5 are tentatively assigned to the Nimish Subgroup (Evans, 1978) of the Labrador Trough. Chemical analyses, including rare earths, are currently being performed by one of the authors (Noel) in order to define more fully the affinities of the suite.

Unit 6 - Wabush Formation

Iron formation and associated lithologies compose the Wabush Formation. The predominant lithology is carbonate and cherty carbonate iron formation, which is locally grunnite bearing and may contain magnetite. Cherty iron formation with tuffaceous fragments occurs locally, and this too is magnetite bearing. Cherty magnetite graywacke and magnetite-bearing siltstone, lithotypes not previously encountered, occur in the northeastern corner of the map area.

Unit 7 - Nault Formation

A fine grained black schist/slate, which outcrops north of the iron formation in the Colville Lake area, is believed to be part of the Nault Formation. It is locally graphite bearing, but is otherwise a rather featureless rock devoid of sedimentary structures.

Unit 8 - Blueberry Lake group

Rocks assigned to this unit were mostly mapped by Wardle (1979a, b) and only the westerly extensions of the unit in the McKay River area were examined by the authors. There, polymictic conglomerate forms the preponderant lithology, with subordinate light green sandstone and siltstone. Clasts in the conglomerate include porphyritic plutonic rocks, quartz, orthoquartzite, slate and felsic tuff fragments. East of McKay Lake, metasandstone and siltstone identical to those included in the Blueberry Lake group contain significant magnetite, suggesting that they may be associated with the iron formation. In the south of the area (not on map) a small body of a porphyritic intrusive rock with rounded inclusions of biotite schist, occurs within the Shabogamo

Gabbro, It appears similar to the andesite porphyry of the Blueberry Lake group described by Wardle (1979b) from the Gabbro Lake area and may be related to the group.

The age of the Blueberry Lake group is presently in doubt (Wardle, 1979b). In the McKay River area, dikes of Shabogamo Gabbro cut metasediments of the group in one locality, and elsewhere inclusions of sandstone considered part of the Blueberry Lake group occur in Shabogamo Gabbro: thus, if the association of these sediments with the Blueberry Lake group is correct, the group may be Aphebian in age, and possibly related to the volcanic rocks of the Nimish Subgroup. If the sediments are not part of the Blueberry Lake group however, as seems possible, then the group may be considerably smaller than indicated on the accompanying sketch map.

Unit 9 - Sims Formation

Orthoquartzite, with minor granule conglomerate, of the Sims Formation, forms two hillcappings in the west of the area. These rocks, which lie unconformably on the Gagnon Group, were mapped by the Newfoundland Department of Mines and Energy in 1978 and are more fully described by Ware (1979) and Ware and Wardle (1979).

Unit 10 - Shabogamo Gabbro

Coarse to fine grained, melanocratic to mesocratic metagabbro and associated chlorite-actinolite-albite schist occurs throughout the map area, in some places as large bodies which effectively blot out the stratigraphy of the Gagnon Group. Relict igneous textures are commonly present, with the mafic minerals largely replaced by actinolite and chlorite. Mylonitic fabrics in metagabbro are seen in several localities throughout the map area, and these may be associated with faults. Disseminated sulphides are found in both metagabbro with relict igneous texture and in the associated chlorite-albite-actinolite schist.

STRUCTURAL GEOLOGY

In the central part of the map area, where exposure is good, the structural geology has been worked out in some detail; elsewhere many of the contacts are poorly defined and the structure is largely interpretative. In the northeast corner of the area, structural trends are northwest and the deformation occurred during the Hudsonian Orogeny. The rocks in this region are gently dipping and appear only slightly deformed. The Grenville Front crosses the upper half of the map area, although its exact location is unknown. South of the Front, evidence for three phases of deformation of Grenvillian age can be found. Well developed tectonic fabrics (S_1) defined by micas and other minerals and possibly associated with major thrust faults are folded into east-west trending folds (F_2), and subsequently into northwest trending folds (F_3) giving rise to the complex map pattern. Examination of the map pattern shows that during the formation of F_2 and F_3 folds, disharmonic folding was common and faulting accompanied fold formation in several localitites. This was probably largely due to the juxtaposition of large bodies of rock of very different ductilities, such as marble/chlorite schist against gabbro and massive lavas. Interpretation in the eastern part, in particular, is tentative and may be revised shortly.

METAMORPHISM

In the north of the map area, metamorphic grade is in the sub-greenschist facies, there has been little recrystallization, and primary structures are visible in many rocks. In the central part of the area the prevailing grade of metamorphism is in the greenschist facies, with chlorite-albite-actinolite assemblages being common in metavolcanic, volcanogenic and metaplutonic rocks. In the extreme south of the area, the metamorphic grade may rise to amphibolite facies. Localized hornfelsing and contact metamorphism of schists occurs around some of the larger gabbro intrusions.

ECONOMIC GEOLOGY

Oxide iron formation is a subordinate lithology of the Wabush Formation in this map area and is unlikely to be of commercial interest for iron ore. Disseminated magnetite occurs in iron formation, chlorite schist and gabbro, but is probably too dispersed to warrant further investigation. Pyrite, pyrrhotite and minor chalcopyrite occur in chlorite schist, conglomerate, gabbro and derived chlorite-actinolite-albite schists. It is probably of primary origin in most rocks but may have been remobilized and locally concentrated in zones of low stress (*e.g.* shear zones) during metamorphism. Some electromagnetic anomalies drilled by Labrador Mining and Exploration Company (Breau, 1957) located minor amounts of massive sulphide mineralization in some holes.

ACKNOWLEDGEMENTS

We would like to thank Helen Norman and David Evans for their unflagging enthusiastic assistance, despite several rather long traverses. Flying services were provided by Ashuanipi Aviation and Universal Helicopters, and logistics were handled by Wayne and E.J. Tuttle in Goose Bay. Discussions with Dick Wardle at various stages during the project have been most helpful.

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CONTINUED GEOLOGIC MAPPING IN THE DAVIS INLET - MISTASTIN LAKE CORRIDOR, LABRADOR

by

J.D. Hill

INTRODUCTION

This is the fourth report on a five year regional mapping project begun in 1977 in the area between Davis Inlet and Mistastin Lake, Labrador. Bedrock mapping in 1979 was completed in N.T.S. areas 13N/12 and 13N/13 at a scale of 1:50,000 using a five person field party supported by float plane and helicopter from Goose Bay. Preliminary mapping was also continued in N.T.S. areas 13M/9 and 13M/16, the results of which will be included in a subsequent publication. Final publication of the whole area will be at 1:100,000. The sketch map given in Figure 1 incorporates the field data of Taylor (1972) in addition to the mapping of J.D. Hill, A. Kerr and J.M. Hill completed in 1979.

Outcrop in the mapped area is only abundant above the treeline on the hills. For this reason, the geology is poorly known in the valleys, particularly in those of the Notakwanon River and Flowers River. Place names are rare so lakes are identified in the text by their elevations in metres (*e.g.* the 356 m lake). Igneous rock names used in the report are those recommended by the I.U.G.S. subcommission (Streckeisen, 1976) with minor modifications given by Hill (1978).

GENERAL GEOLOGY

The area mapped lies in the southern part of the Nain igneous complex and consists of two age groups of gneisses and two age groups of undeformed igneous rocks. Layered gneisses occurring as small interplutonic screens are believd to be Archean in age. A larger gneiss terrain to the southwest is contiguous with a much more extensive belt of gneisses included in the Churchill structural province (Taylor, 1971). These rocks show a wide range in K-Ar ages from 1.2 to 2.2 billion years (Emslie, 1978) but they are poorly understood and may be Archean in part (Greene, 1974). In any case, all of the Churchill gneisses in the area mapped were deformed by the Hudsonian Orogeny and must be older than about 1.7 billion years (Emslie, 1978).

The older group of undeformed igneous rocks range from anorthosite to granite in composition and are Elsonian in age (Emslie, 1978). The younger group consists of peralkaline granite and is part of a larger granite - volcanic rock complex extending to the east (Hill, 1979). Preliminary unpublished Rb-Sr dates by C. Brooks of the University of Montreal suggest these rocks may be significantly younger than Elsonian.

No occurrences of economic minerals were found within the map area.

DESCRIPTION OF UNITS

Archean Gneisses (Unit 1)

Unit 1 consists of a large variety of plagioclase-pyroxene and plagioclase-quartz-biotite gneisses that range from gabbro to granite in composition. Banded plagioclase-pyroxene gneiss appears to be the main rock type. It occupies whole outcrops and is liberally invaded by slightly deformed biotite granite and undeformed leucogranite. The plagioclase-pyroxene gneiss also occurs locally as trains of inclusions in banded plagioclase-quartz-biotite gneiss. This latter lithology is more restricted in occurrence and contains up to 25% mafic minerals including accessory graphite. In areas adjacent to younger undeformed intrusions, the gneisses commonly form extensive agmatite with the igneous rocks.

The gneisses included in Unit 1 are characterized by regular banding and a granoblastic texture. They are similar to gneisses farther east that belong to the Nain structural province (Hill, 1979). For these reasons, these gneisses are believed to be Archean in age. However, the gneisses in the two screens south of the 123 m lake are intermediate in character between the Archean gneisses to the east and the Aphebian(?) gneisses to the west. Therefore, their ages are less certain.

Aphebian(?) Gneisses (Unit 2)

The gneisses exposed in the southwest part of the map area are contiguous with a much larger belt of gneisses to the west which are part of the Churchill structural province (Taylor, 1971). They are characterized by a variably developed cataclastic mineral foliation and the general occurrence of biotite and garnet bearing metamorphic mineral assemblages. This fabric and mineralogy is preserved throughout the gneiss terrain with no regard to proximity to younger plutons. The position of the boundary between the Nain and Churchill structural provinces is masked by younger intrusions but it appears to lie in approximately the same position as that determined by Taylor (1972, 1977) by reconnaissance mapping.

Unit 2a is composed of a large variety of fine to coarse grained, banded feldspar-quartz-biotite-garnet gneisses that are tonalitic in average composition. Individual bands vary from 1 mm to 10 cm in width and range in composition from leucocratic granite to amphibolite and biotite schist. The dominant foliation is defined by a cataclastic alignment of all of the constituent minerals except garnet. In a few outcrops, the amount of strain is variable across strike. This has resulted in the alternation of mylonitic and more granoblastic fabrics which magnifies any compositional banding present. Garnet occurs as subhedral to euhedral crystals up to 5 cm in diameter and appears to generally predate the mylonitic fabric. In addition, the garnet is typically altered to biotite and chlorite. The gneissosity defines folds in many outcrops whose axes are parallel to the strike of the foliation. Slightly deformed biotite-garnet leucogranite is commonly present as concordant sheets which locally truncate the gneissosity.

The dominant lithology in Unit 2a is a banded, medium to coarse grained biotite-garnet tonalite gneiss whose origin is uncertain. A smaller portion of Unit 2a consists of finely banded, fine grained biotite-garnet gneiss that appears to be sedimentary in origin. These rocks contain individual bands with up to 70% quartz which are typically graphitic and pyritiferous. In addition, cordierite and sillimanite have been observed locally. Immediately west of the 191 m lake, a band of feldspar-quartz flaser gneiss at least 50 m thick and a band of plagioclase-pyroxene(?) gneiss 10 to 30 m thick are concordant and contained within a belt of paragneisses. The feldspar-quartz flaser gneiss is extremely homogeneous in composition from outcrop to outcrop. The rock is not banded except for ribbons of quartz and feldspar developed on a millimetre scale and it contains no inclusions or dikes. It is medium grained, mylonitic, white weathering and has about 1% biotite. This rock is in abrupt and concordant contact with dark colored plagioclase-pyroxene(?) gneiss of gabbroic composition. These features are suggestive of a sequence of felsic and mafic volcanic rocks lying within a sedimentary terrain.

Unit 2b consists of coarse grained feldspar-quartz-biotite-garnet gneiss containing feldspar augen up to 10 cm long. These rocks vary only slightly from an average composition of

LEGEND

Helikian (and younger)

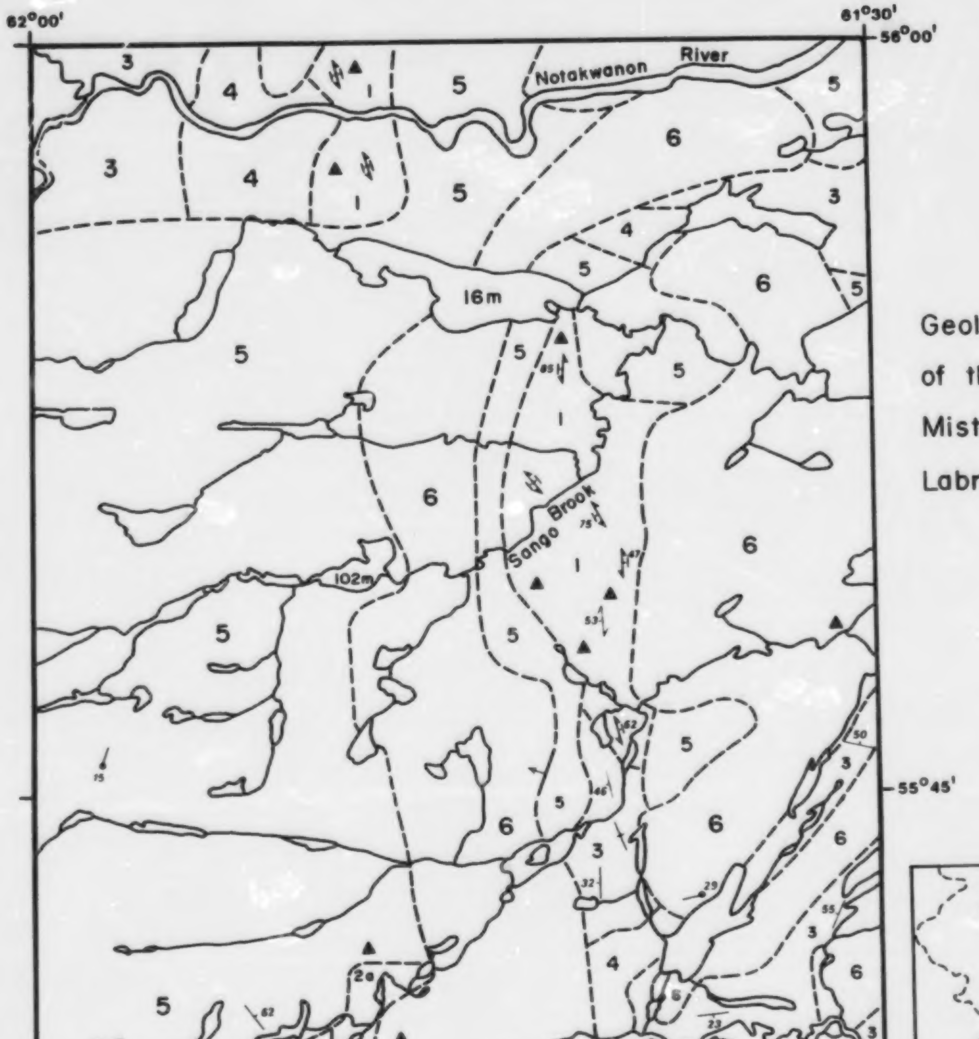
6	fine to coarse grained, equigranular, leucocratic peralkaline granite.
5	medium to coarse grained, rusty weathering pyroxene-olivine granite and quartz monzonite.
4	medium grained, rusty weathering pyroxene-olivine-amphibole syenite, monzonite and monzodiorite.
3	coarse and very coarse grained plagioclase cumulate and minor plagioclase-olivine cumulate, locally grading into narrow chilled margins of fine grained olivine gabbro.

Aphebian (and older?)

2	2a, fine to coarse grained, banded, mylonitic feldspar-quartz-biotite-garnet gneiss with an average composition of tonalite. 2b, coarse grained, homogeneous mylonitic feldspar-quartz-biotite-garnet orthogneiss with an average composition of granodiorite. 2c, medium grained, slightly deformed quartz diorite.

Archean

1	banded plagioclase-pyroxene and plagioclase-quartz-biotite gneiss, locally intruded by abundant granite and pegmatite.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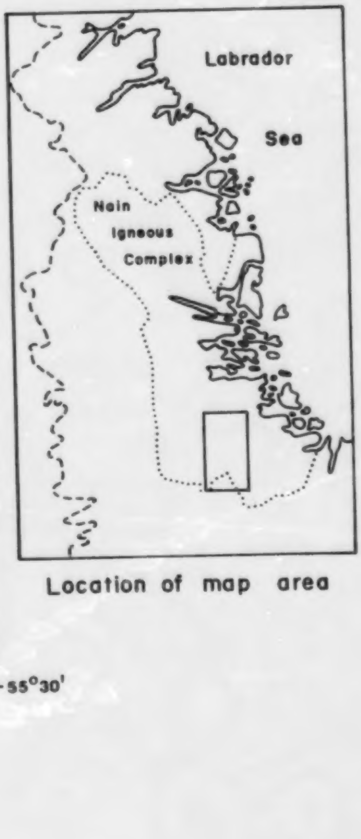
Geology of a portion of the Davis Inlet–Mistastin Lake Corridor, Labrador.


Labrador
Sea
Nain
Igneous
Complex

Location of map area

granodiorite. Biotite ranges from 5 to 15% and garnet varies from 0 to 15%. The rocks possess a cataclastic fabric in which fine to medium grained quartz, feldspar and biotite wrap around larger feldspar augen. Garnet appears to have formed prior to development of the fabric and is altered to biotite and chlorite. Textures vary from mylonitic devoid of augen to relatively massive and plutonic looking, even within single outcrops. The contact of Unit 2b with Unit 2a was observed in two places north of the 203 m lake. At the more southern locality, the contact is abrupt and concordant with the mylonitic fabric. The foliation is similar in intensity and orientation on both sides of the contact. Inclusions of Unit 2a occur within Unit 2b immediately west of the contact. Farther north, the contact is more gradational with concordant sheets of Unit 2b in Unit 2a increasing in abundance until the rocks of Unit 2a disappear entirely. The plutonic textures, contact relationships and homogeneous composition of Unit 2b suggest these rocks were originally part of one or more igneous intrusions of granodiorite composition, emplaced prior to the Hudsonian Orogeny but after the formation of Unit 2a.

Unit 2c consists of slightly deformed quartz diorite which underlies a poorly defined area southeast of the 191 m lake. The rocks are homogeneous in composition and contain about 15% quartz and 30 to 40% biotite and pyroxene(?). The contact relationships with the other units are unknown. However, the quartz diorite must be older than the Elsonian intrusions since it is deformed and the latter are not. For this reason, the quartz diorite is included with the Aphebian(?) rocks although it is probably younger than the main period of Hudsonian deformation.

Gabbroid Plutons (Unit 3)

Anorthosite, leucogabbro and gabbro form a series of isolated plutons within the map area. Some of these are similar in lithology to each other and may once have been part of a larger body, disrupted by younger granite intrusions. These rocks show all variations between gabbro and anorthosite and are grouped under the term gabbroid (Streckeisen, 1976).

The gabbroid plutons are dominated by coarse and very coarse grained anorthosite and leucogabbro in which plagioclase varies in amount from about 65 to 100%. The mafic minerals are mainly olivine, pyroxene and Fe-Ti oxides and these are generally interstitial to plagioclase except locally where olivine is subhedral to euhedral and equidimensional in habit. In many places, the olivine and oxides form small oikocrysts giving the rock a spotted appearance. In contrast, pyroxene never occurs as oikocrysts but only as small wedges lying between plagioclase tablets. An unusual type of leucogabbro occurs in the southwest part of the area. There, the rocks contain varying amounts of quartz up to 10%. Although parts of these plutons contain numerous blocks of gneiss, the presence of quartz appears to be unrelated to the proximity to the inclusions.

In a few places where bedrock exposure is sufficient, the coarse grained plagioclase-rich rocks in the interiors of the plutons can be traced gradationally into fine grained olivine gabbro at the margins of the plutons. However, this marginal phase is absent along the southern contact of the gabbroid pluton directly west of the 123 m lake. There, the contact zone is marked by a large area of agmatite in which outcrops of gneiss alternate with outcrops of rusty, quartz-bearing leucogabbro.

Textures and structures in the gabbroid plutons suggest the anorthosites and leucogabbros are cumulate in origin. Rhythmic layering and plagioclase lamination are sporadically developed in all of the gabbroid plutons. Although olivine appears to be a minor cumulus phase in some outcrops, plagioclase is by far the dominant cumulus mineral. Pyroxene, Fe-Ti oxides and generally olivine are intercumulus in nature. Plagioclase megacrysts up to 10 cm long are present in some places. Blocks of older anorthosite are found in leucogabbro in a few outcrops, especially along the western part of the Notakwanon River. One peculiar structure deserves special mention. It consists of irregular to disc shaped lenses of leucogabbro enclosed within anorthosite. In one outcrop, the lenses are aligned parallel to a plagioclase lamination which is developed in both lithologies. On an island in Sango Bay to the east of the map area, this mixed rock merges across the strike of the lamination into a rhythmically layered sequence of the same two rock types. For this reason, the structure is believed to have been caused by the disruption of layered cumulates prior to complete consolidation.

The gabbroid plutons are undeformed and are correlated with the numerous other anorthositic intrusions of Elsonian age to the north and south.

Syenite, Monzonite, Monzodiorite (Unit 4)

Unit 4 consists of relatively homogeneous plutons that range in composition from syenite to monzodiorite. These rocks are typically medium grained, massive and deeply weathered in outcrop. Pyroxene, fayalitic olivine and amphibole are the main mafic phases. Quartz may be absent or it may be present in amounts up to a few percent. A typical mode is given for a syenite collected north of the 123 m lake in Table 1.

The shapes of the plutons of Unit 4 are generally unknown due to the lack of outcrops along contacts. However, the west side of the Unit 4 pluton on the Notakwanon River in the northwest part of the map area is partly exposed. The main part of the pluton appears to be linked with a series of monzonite caps overlying anorthosite on small hills to the west which have been isolated by erosion. If this interpretation is correct, then the western part of the pluton has an approximately horizontal base.

The Unit 4 plutons intrude the Elsonian gabbroid plutons and are in turn intruded by pyroxene-olivine granite of Unit 5.

Table 1: Representative modes of some igneous rocks from the map area.

	A	B	C	D
plagioclase	96.7	3.8	11.9	
K-feldspar		75.7	56.6	72.9
quartz		0.3	18.3	24.7
olivine		6.4	5.2	
clinopyroxene	2.1	7.6	6.0	1.6
amphibole	0.1	3.0	0.9	0.9
opaques	0.9	3.1	0.6	
accessories	0.2	0.1	0.7	0.2
No. of counts	817	1061	852	1052

A - coarse grained plagioclase adcumulate (Unit 3, sample JH-77-125).
B - medium grained syenite (Unit 4, sample JH-77-130A).
C - fine grained pyroxene-olivine granite (Unit 5, sample JH-78-173).
D - medium grained peralkaline granite (Unit 6, sample JH-78-020B).

Pyroxene - Olivine Granite (Unit 5)

Pyroxene-olivine granite forms several plutons in the map area and increases in proportion relative to the other units farther west. It is generally medium to coarse grained, massive and deeply weathered in outcrop. Quartz is variable in amount and ranges from 10 to 35%. Where the quartz content is low, the granite becomes difficult to distinguish from the monzonites of Unit 4. The mafic minerals vary between 5 and 15% and include pyroxene, olivine and amphibole as the main phases. Biotite is generally lacking except in one area northwest of the 123 m lake where it is the dominant mafic mineral. A representative mode is given in Table 1.

The pyroxene-olivine granite is typically inequigranular and can be distinguished from the peralkaline granite of Unit 6 on this basis. Finer grained crystals of quartz and mafic minerals tend to lie between larger feldspar tablets. In some places, this texture is developed to the point where the quartz content is difficult to quantify in the field. Southwest of the 16 m lake, two textural varieties of similar composition are present. A fine grained, porphyritic phase is intruded by medium to coarse grained granular granite and the two types are well mixed within single outcrops.

The pyroxene-olivine granite is correlated with similar granites of Elsonian age farther north in the Nain igneous complex (Wheeler, 1955). The granite intrudes both Unit 3 and Unit 4 and appears to be the youngest member of the Elsonian igneous rock suite in the area.

Peralkaline Granite (Unit 6)

Coarse grained, equigranular peralkaline granite is the dominant unit in the eastern part of the area. It is part of a much larger mass of granite lying to the east (see Hill, 1979). Unit 6 is distinguished in the field from the granite of Unit 5 by its leucocratic composition, white weathering outcrops and coarse, interstitial amphibole crystals. The peralkaline granite is intrusive into all of the other units.

The peralkaline granite consists mainly of perthitic alkali feldspar, quartz and arfvedsonite-riebeckite. The amphibole is typically interstitial to the quartz and feldspar suggesting late crystallization. Sodic pyroxene occurs as an accessory phase in some outcrops. A representative mode is given in Table 1.

The peralkaline granite is generally massive and homogeneous, and dikes of related pegmatite and inclusions of older rock occur only rarely. However, adjacent to contacts with other units, the granite becomes fine grained and prophyritic with quartz and perthite phenocrysts. In addition, it commonly possesses an inequigranular groundmass with small, medium and coarse grained patches lying in, and gradational with, the fine grained material. Immediately north of the 356 m lake, fine grained, porphyritic peralkaline granite is exposed over a large area and may represent a roof phase in the pluton.

In the northeast near the Notakwanon River and in the south just west of the 356 m lake, rocks included in Unit 6 may belong to Unit 5. They display characteristics intermediate between the two types of granite and their affinity is uncertain until thin section data are obtained.

An undefined zone of breccia occurs in the peralkaline granite about 1 km north of the 356 m lake. The breccia consists of angular fragments of fine to medium grained granite which range from less than 1 mm to about 4 cm in diameter. The fragments are set in a dark red-brown, very fine grained matrix that appears to be comminuted granite. The breccia grades into the surrounding granite which is similar in texture and composition to the fragments. Miarolitic cavities and fractures associated with the breccia are lined with drusy quartz. The breccia occurs within the area of fine grained granite described above and may have been caused by explosive degassing of the crystallizing granite magma near the roof of the intrusion.

ACKNOWLEDGEMENTS

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LAKE SEDIMENT GEOLOGY

LLOYD'S RIVER AREA, SOUTHWEST NEWFOUNDLAND

by

A.J. Butler

LOCATION AND SAMPLING STATISTICS

The Lloyd's River area, for purposes of this report, covers approximately 20,600 km^2 of southwest Newfoundland, south of latitude 49°30'N and west of longitude 57°00'W.

The sampling phase of the project began on May 30, 1979, and was completed on August 8, 1979. During that period 255 hours of helicopter time was used and 2877 profundal lake sediment samples were collected. The average sampling density for the project was one sample per 7.1 km^2.

SAMPLING METHOD

Sampling was conducted from the float of a helicopter by allowing a weighted, hollow, pipelike sampler (Figure I) to free fall through the water to penetrate the organic rich sediment accumulations at the lake centre bottom. The sampler was retrieved by means of a rope attached to a metal loop at the upper section of the sampler near the stabilizing fins. During retrieval a butterfly valve, located at the extreme lower end of the sampler, was closed by the weight of the sample and prevented sample loss. After the sampler was retrieved, a plastic scoop was inserted into a tapered notch cut near the centre of the sampler which was then inverted to allow the sample to slide into the scoop. The sample was examined and then transferred to a pre-numbered kraft paper sample bag. Some features of the sample, such as color and composition, and the sample site, such as water depth, general water level and nature of the surrounding terrain, were recorded. Other features, such as UTM co-ordinates of the sample site and the area of the lake from which the sample was collected, were recorded from NTS 1:50,000 scale maps on returning to camp.

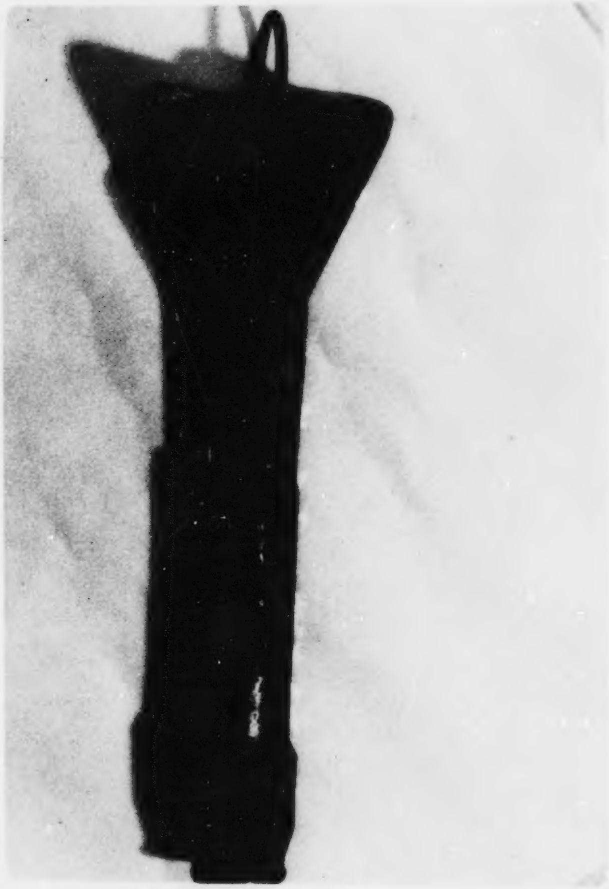
SAMPLE PREPARATION

The samples were air dried in the field and then forwarded to the Department of Mines and Energy laboratory in the Howley Building, St. John's for final drying in ovens at approximately 40°C. The samples were then disaggregated using a rubber mallet and a porcelain mortar and pestle, and the sample material passed through a 180 μm stainless steel sieve. The <180 μm fraction was stored in a plastic vial prior to analysis. One gram portions of these samples were weighed and placed in special vials for uranium analyses.

ANALYTICAL METHODS

Uranium was determined by neutron activation/delayed neutron counting at Nuclear Activation Services Limited, Hamilton, Ontario. The elements Cu, Pb, Zn, Co, Ni, Ag, Mn, Fe and Mo were determined by a method developed at the Geological Survey of Canada. For Cu, Pb, Zn, Co, Ni, Ag, Mn and Fe, a 1 g sample aliquot was digested in 6 ml of 4M HNO_3 - 1M HCl solution at 90°C for 2 hours, and the final solution made up to 20 ml. For Mo, 0.5 g was digested in 1.5 ml of concentrated HNO_3 at 90°C for 30 minutes, followed by 0.5 ml of concentrated HCl at 90°C for an additional 90 minutes, and the addition of 8 ml of 1250 μg/ml Al solution when cool. A Varian Techtron AA5 atomic absorption spectrometer was used for the

Figure I. Lake Sediment Sampler.



determination of these metals, and automatic simultaneous background correction using a hydrogen continuum lamp was used for the determination of Pb, Ni, Co and Ag. Loss on ignition was determined on the samples by heating a 0.5 g aliquot of the sample material to 500°C and maintaining this temperature for 4 hours; the weight loss is then expressed as a percentage of the initial sample weight. Determination of the F concentration of the sample was done using a method modified from Ficklin (1970) which includes fusing a 0.25 g aliquot of sample with a KNO_3/Na_2CO_3 flux and the residue dissolved in a citrate buffer. The solution was then analysed using Phillips fluoride ion selective electrodes and an Orion Research digital millivoltmeter, connected via an electrode switch.

CONTROLS

The accuracy and precision of all analyses were monitored by the use of blind duplicates and bulk control samples. A pair of blind duplicate samples was prepared from one of the field duplicate samples and placed in two separate vials with non-adjacent sample numbers. This constituted the first and second members of a blind duplicate pair. Control samples were bulk samples of lake bottom sediments.

Each block of 20 samples comprised 18 unknown samples, the second member of a blind duplicate pair of samples and one control reference sample. A measure of the precision 'p' for each duplicate pair was calculated from the formula:

$$p = \frac{[V_1 - V_2] \times 100\%}{\overline{V}_{1,2}}$$

where:

V_1 = first value of an analysis of a blind duplicate pair,

V_2 = second value of an analysis of a blind duplicate pair,

$\overline{V}_{1,2}$ = mean of V_1 and V_2

The analyses of all bulk control reference samples were compiled until each control was analysed at least 25 times. Means and standard deviations were then calculated for these samples.

For a block of 20 samples to be accepted two requirements had to be met:

1) The value of 'p' for each duplicate pair in a block was required to be within the limits given in Table 1.

2) The results of the analysed bulk control samples had to fall within ± 3 standard deviations of the mean for each control sample.

If either of these requirements were not met the block of 20 samples in which the anomalous control or blind duplicate sample was contained, were re-analysed.

In order to determine overall the reproducibility of the data, including the variability due to sampling and analysis, duplicate lake sediment samples were collected at a frequency of 1 sample in 18; and statistically analysed, following the method of Garrett (1973).

GEOLOGY

The rocks of this area range in age from Helikian to Carboniferous (Williams, 1967). Cambrian and Ordovician sedimentary rocks are located mainly in the northwest section of the area and overlie Helikian gneisses and schists of the Long Range Complex. These sedimentary rocks are in turn structurally overlain by the transported mafic and ultramfaic rocks of the Bay of Islands allochthon. Carboniferous rocks occur to the southwest, in the Codroy Basin, and to the northeast, in the Deer Lake Basin. The southeast section of the area contains Ordovician to Devonian sedimentary and volcanic rocks and their metamorphosed equivalents. Many Devonian and earlier granite bodies occur throughout the area, but predominate along the south coast and in the Topsails area east of Grand Lake. Mafic and ultramafic rocks occur in the Port aux Basques area, in the Lloyd's Lake area, in the Bay of Islands area and in association with the Topsails granite. Foliated granites and anorthosites occur in the Stephenville area.

TABLE 1

Element	Range ($V_{1,2}$)	Tolerance
Cu (ppm)	2-5	±100%
	5.1-10	±50%
	10.1-30	±30%
	30.1-200	±20%
	200.1-10,000	±25%
	>10,000	±25%
Pb (ppm)	2-10	±100%
	10.1-20	±50%
	20.1-100	±30%
	100.1-1000	±25%
	1000.1-10,000	±30%
	>10,000	±30%
Zn (ppm)	2-5	±100%
	5.1-20	±50%
	20.1-100	±25%
	100.1-300	±20%
	300.1-10,000	±25%
	>10,000	±25%
Co (ppm)	2-10	±100%
	10.1-20	±50%
	20.1-100	±25%
	100.1-300	±20%
	300.1-10,000	±25%
	>10,000	±25%
Ni (ppm)	2-5	±100%
	5.1-10	±50%
	10.1-20	±40%
	20.1-100	±25%
	100.1-300	±20%
	300.1-10,000	±25%
	>10,000	±25%
Ag (ppm)	0.2-1.0	±100%
	1.1-5.0	±50%
	5.1-10.0	±30%
	10.1-100	±25%
	100.1-200	±20%
	200.1-10,000	±25%
	>10,000	±25%

TABLE 1 (contd)

Element	Range ($V_{1,2}$)	Tolerance
Mn (ppm)	5-10	±100%
	10.1-100	±50%
	100.1-500	±30%
	500.1-1000	±25%
	1000.1-2000	±20%
	2000.1-10,000	±25%
	>10,000	±25%
Fe (%)	0.02-0.1	±100%
	0.11-0.5	±50%
	0.51-1.0	±40%
	1.01-3.0	±30%
	3.01-10.0	±20%
	10.01-100	±25%
Mo (ppm)	2-4	±100%
	4.1-6	±50%
	6.1-10	±40%
	10.1-25	±30%
	25.1-100.0	±25%
	100.1-10,000	±30%
	>10,000	±30%
F (ppm)	<40	±100%
	40-100	±50%
	100-200	±40%
	200-500	±30%
	>500	±25%
LOI (%)	1-5.0	±120%
	5.1-10.0	±100%
	10.1-20.0	±50%
	20.1-100.0	±25%
U (ppm)	0.20-0.50	±100%
	0.51-1.00	±60%
	1.01-2.50	±40%
	2.51-5.00	±30%
	5.01-15.00	±25%
	>15.00	±20%

MINERAL POTENTIAL

The most significant base metal occurrences are located at Tulk's Pond south of Red Indian Lake and York Harbour in the Bay of Islands (Douglas, 1976). Numerous smaller copper showings have been recorded in the Gregory River area and in several localities along the south coast. Lead occurrences are located on the Port au Port Peninsula, in the Goose Arm area of the Bay of Islands and associated with the Cape Ray Fault. Known zinc occurrences predominate on the Strickland property in La Poile Bay and near Cape Anguille. A significant occurrence of wolframite associated with several base metals is located at Grey River on the south coast. Further exploration work is being done on a gold prospect north of Isle aux Morts and a large scale exploration program is underway for uranium in the Carboniferous rocks of the Deer lake Basin.

Minor occurrences of arsenic, molybdenum, nickel and fluorine are also known in the area. Chromite showings are abundant in the Lewis Hills, south of Corner Brook.

Many of these showings are indicated in Figure II.

RELEASE OF SURVEY DATA

This information will be released as a set of six open files in the spring of 1980*. Each open file will include single element distribution maps of each of 11 elements plus a sample location map, in accordance with the National Topographic System (Figure II) on a scale of 1:250,000 for a total of 72 maps, together with a microfiche of the field and analytical data and explanatory notes. Also included in this release will be the reanalysed results of open File Nfld. 787 (McArthur *et al.* 1975), the Carboniferous Codroy - St. George Bay area, and part of Open File Nfld. 708 (Davenport *et al.* 1974), south of Gros Morne National Park. The title "LLOYD'S RIVER AREA, SOUTHWEST NEWFOUNDLAND" will NOT be used on the open file release next spring. The maps will be named as shown in Figure III.

ACKNOWLEDGEMENTS:

This project is funded under the Canada-Newfoundland Mineral Development Subsidary Agreement. The helicopter was supplied on a contractual basis by Sealand Helicopters Ltd., St. John's, and field assistance was provided by Hazen Russell and Randy Hamlyn. A special thank you is extended posthumously to Tim Neuss, our pilot, without whose assistance the sampling project would not have been completed successfully.

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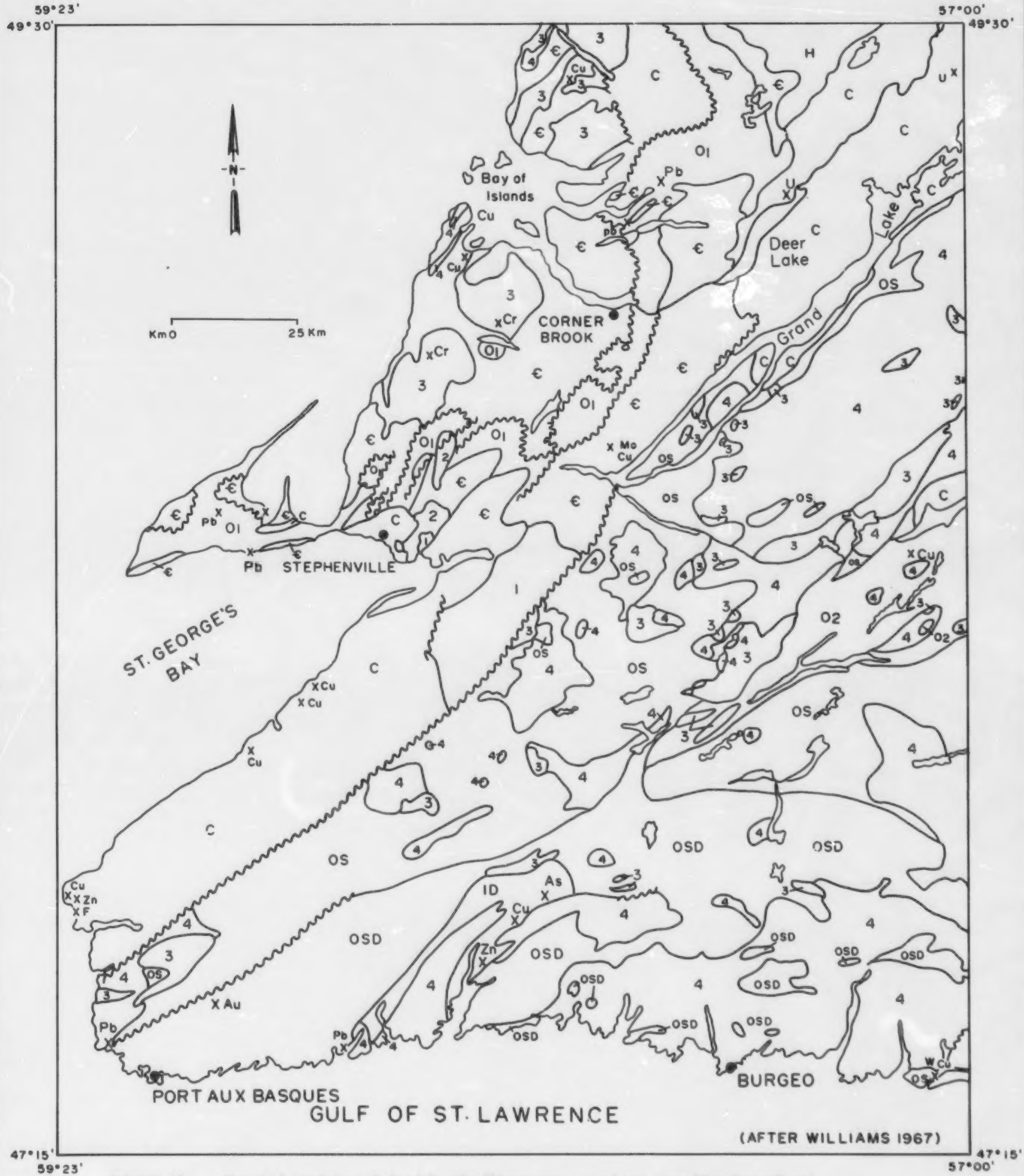
*The exact time of release will be published approximately four weeks in advance, and notifications of it will be sent to all companies on our mailing list.

LEGEND

C	Carboniferous - undivided conglomerate, sandstone, siltstone, shale, limestone.
ID	Lower Devonian - undivided conglomerate, arkose, acid volcanic rocks
OSD	Ordovician, SIlurian, Devonian and earlier - undivided sandstone, slate, graywacke, and acid to mafic volcanic rocks
OS	Ordovician, Silurian and earlier - undivided sandstone, slate, graywacke, and acid to mafic volcanic rocks
O_2	Ordovician - volcanic rocks, slate, graywacke, siltstone, chert, Central Newfoundland
O_1	Ordovician - limestone, dolomite, quartzite, sandstone, shale, Westrn Newfoundland
	Cambrian - undivided limestone, shale, quartzite, slate, some basalt
H	Helikian or earlier - Long Range Complex
4	Granite and granitic derivatives
3	Mafic and ultramafic sequences
2	Foliated granitic rocks of Indian Head COmplex
1	Anorthosites and related rocks


59°23'
49°30'
57°00'
49°30'
N
Km 0
25 Km
Bay of Islands
CORNER BROOK
Deer Lake
Grand Lake
STEPHENVILLE
ST. GEORGE'S BAY
PORT AUX BASQUES
GULF OF ST. LAWRENCE
BURGEO
H
C
€
OI
O2
OS
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I
2
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Cu
Pb
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U
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F
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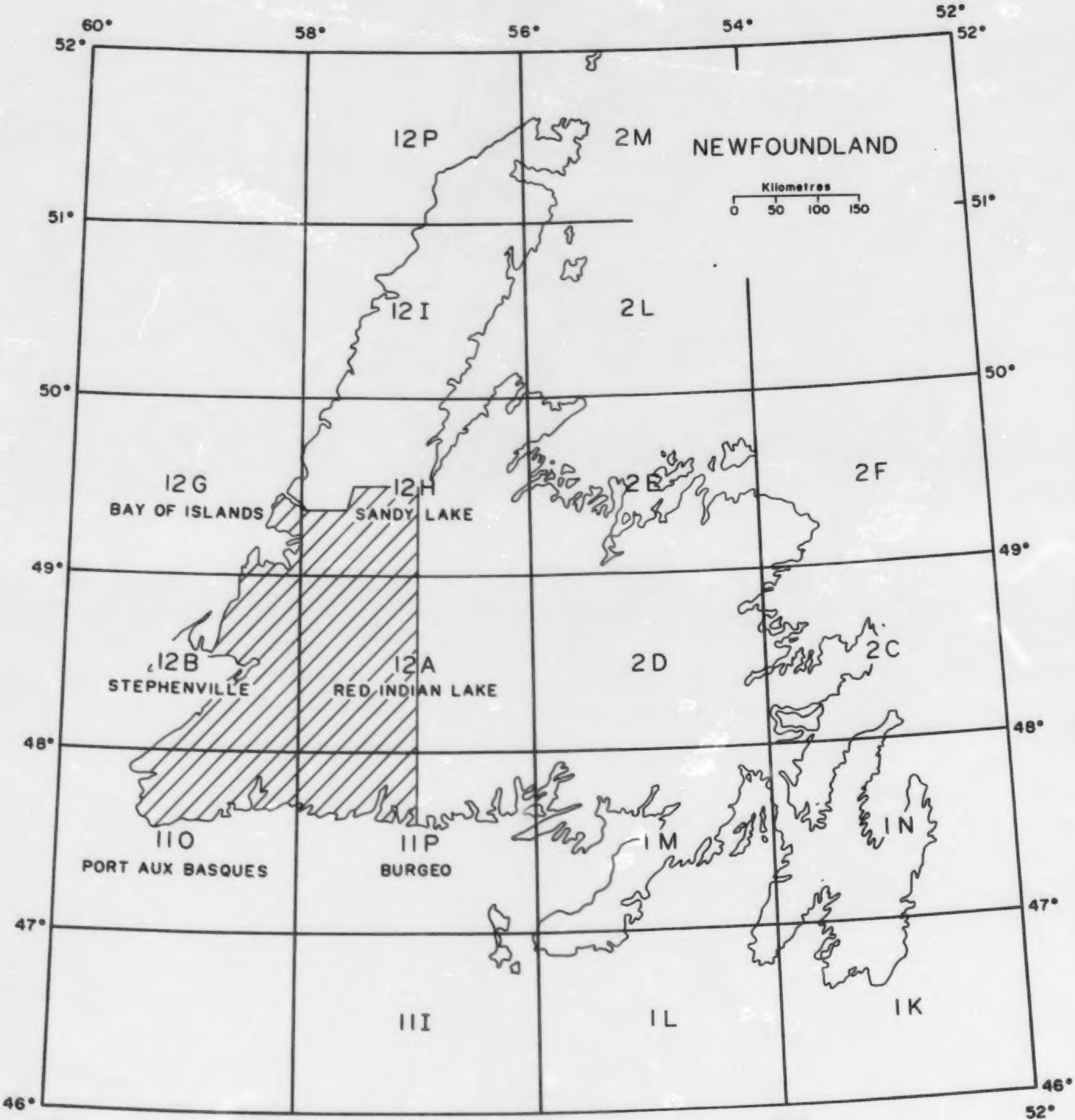
W
(AFTER WILLIAMS 1967)
47°15'
59°23'
47°15'
57°00'

Figure II. General geology of the Lloyd's River area, southwestern Newfoundland.

Figure III. Index to map sheets included in Lloyd's River geochemical lake sediment survey, southwestern Newfoundland. Map sheets indicated by name will be available individually upon request when the file becomes available in late spring, 1980.



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12P
2M
NEWFOUNDLAND
Kilometres
0
50
100
150
12I
2L
12G
BAY OF ISLANDS
12H
SANDY LAKE
2E
2F
12B
STEPHENVILLE
12A
RED INDIAN LAKE
2D
2C
11O
PORT AUX BASQUES
11P
BURGEO
1M
1N
11I
1L
1K

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GEOCHEMICAL AND GEOPHYSICAL FOLLOW-UP STUDIES IN LABRADOR

by
J. McConnell

INTRODUCTION

During 1977 and 1978, reconnaissance lake sediment and water data were collected from a 134,000 km^2 (52,000 mi^2) area of southeastern, central and western Labrador under the Canada-Newfoundland Uranium Reconnaissance Program (G.S.C. 1978 and 1979). In 1978, the Department of Mines and Energy initiated a follow-up program within the region, particularly where mineral rights were open, to further define and evaluate the significance of geochemically anomalous areas. During 1978, 10 such areas, all having anomalously high uranium contents, were variously investigated by high density lake sediment and water sampling, airborne gamma ray and ground work (McConnell 1978, Kerswill and McConnell 1979). Three new uranium occurrences within the Grenville province were found and subsequently were staked by private industry.

The continuation of the follow-up program in 1979 concentrated on two aspects. Firstly, 14 areas having abnormally high base metal or uranium contents in the reconnaissance data and having a variety of geological settings were investigated by high density lake sediment and water sampling and where appropriate, airborne gamma ray surveying with limited ground follow-up (see Figure). Secondly, work was continued on the G-1 Grid where uraninite mineralization in granitic rocks was discovered last year. The object of this second study was to characterize the geochemical dispersion pattern in the overlying till, peat and stream waters, and to test and compare the effectiveness of surveys for radon in soil gas and gamma radiation in bedrock and float as guides to mineralized areas.

REGIONAL FOLLOW-UP

Initial follow-up procedures on the 9 base metal, 4 uranium and one molybdenum-fluorine anomalies consisted of high density lake sediment and water sampling. In total 841 samples from 2900 km^2 were collected. Water samples from several of the base metal anomalies were analyzed colorimetrically in a field laboratory using a dithizone method. This proved to be a rapid, fairly simple and effective way of measuring the heavy metal content (principally zinc) of lake and stream waters thus permitting the field party to make immediate ground searches for the sources of high metal values. Subsequent comparison of the dithizone analyses with those obtained by atomic absorption spectrophotometry for zinc produced a good correlation even at low levels of a few parts per billion. Field determinations of pH were made on all water samples and U and F analyses will be done for waters collected over U anomalies. Lake sediment samples are being analyzed for U, Cu, Pb, Zn, Ni, Co, Mo, F, Ag, Mn and Fe and for loss-on-ignition.

Airborne gamma ray surveys were flown over anomalies 9, 10 and 11 using a McPhar Spectra II spectrometer with a 5 channel graphical output and a 4100 cm^3 crystal mounted in a Bell 206-B helicopter. The spectrometer equipment was on loan from the Geological Survey of Canada and was installed and operated by their representative. A total of 890 km line were flown using a one km line spacing.

Results of the regional follow-up survey will be published as an open file before the 1980 field season.

DETAILED FOLLOW-UP, G-1 GRID

Uranium mineralization in granitic rocks assaying up to 2900 ppm U was discovered in 1978 north of Lake Melville (see Figure). The area is characterized by about 1% outcrop, thin to thick till and peat cover and a tree cover of black spruce and balsam fir. Two streams transect the grid. Several geochemical and geophysical exploration methodologies were tested across the grid in the hope that the resulting data would offer a means of comparing the effectiveness of the various techniques in detecting similar uranium mineralization in comparable physiographic settings.

Of the various elements analyzed in the overburden samples (U, Cu, Pb, Zn, Ni, Co, Ag, Mo, Fe, Mn and F), U gives the best reflection of bedrock mineralization as indicated by scintillometer surveys. The anomaly definition is, however, considerably improved by considering the organic content of the sample as well. Regression analysis of uranium against loss-on-ignition reveals a strong positive correlation between the two, presumably because of the strong cation exchange capacity of the peat fraction relative to that of the mineral soils. Molybdenum in overburden samples, despite its observed association with uranium mineralization as molybdenite, gives very little geochemical relief and produces no identifiable pattern which may be correlated with that of uranium.

Scintillometer surveys, as expected, give a good definition of uranium mineralization in bedrock where outcrops are present. Additionally, readings taken on local float both within and outside of the area of outcrop exposure suggest a more extensive region of mineralization than can be known without trenching or drilling. Scintillometers were useful in identifying radioactive rock through peat cover to a depth of about 20-30 cm.

The radon survey indicates anomalously high values over the area of known mineralization in bedrock as defined by the spectrometer surveys. In addition, it reveals lower order anomalies in areas of deep overburden where outcrop and float are scarce or absent. The significance of these other anomalies is uncertain. One limitation of the method in this area was the frequent presence of waterlogged test sites which usually resulted in very low radon readings. Weather conditions during the survey were unusually severe; intermittent rain, often heavy, was continuous during the period.

Data from the detailed follow-up work at G-1 were published in October as Lab. Open File 457.

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INDEX TO ANOMALIES

Anomaly No.	Regionally Anomalous Elements	- Work Done -	
		Lake Sediment/ Water Sampling	Airborne γ-Ray Survey
1	Zn, Ni, As	X	
2	As, Ni, Cu	X	
3	Zn, Cu, As, Ni	X	
4	Zn, Cu	X	
5	Cu, Ni	X	
6	Zn	X	
7	Zn, Cu, As, Ni, U	X	
8	Zn, Pb, Cu, Mo	X	
9	U	X	X
10	U, Cu, As	X	X
11	U	X	X
12	U, F, Zn	X	
13	Mo, F	X	
14	Cu, Ni, Zn	X	

G-1 A 1 x 1.4 km grid was cut and chained. Overburden, rock and water sampling and radon and spectrometer surveying were conducted.

GEOLOGY

GRENVILLE PROVINCE

HADRYNIAN	▦	Supracrustal arkosic sedimentary rocks of the Double Mer Formation
HELIKIAN AND APHEBIAN	▒	Metamorphosed equivalents of the Seal and Bruce River Groups
HELIKIAN AND EARLIER	▨	Metamorphic rocks, mainly quartzofeldspathic gneisses

CHURCHILL PROVINCE

HELIKIAN	⁘	Supracrustal sedimentary and volcanic rocks of the Seal Group
APHEBIAN	⁙	Sedimentary and volcanic rocks of the Labrador Trough
APHEBIAN AND EARLIER	░	Metamorphic rocks, mainly quartzofeldspathic gneisses and granites

NAIN PROVINCE

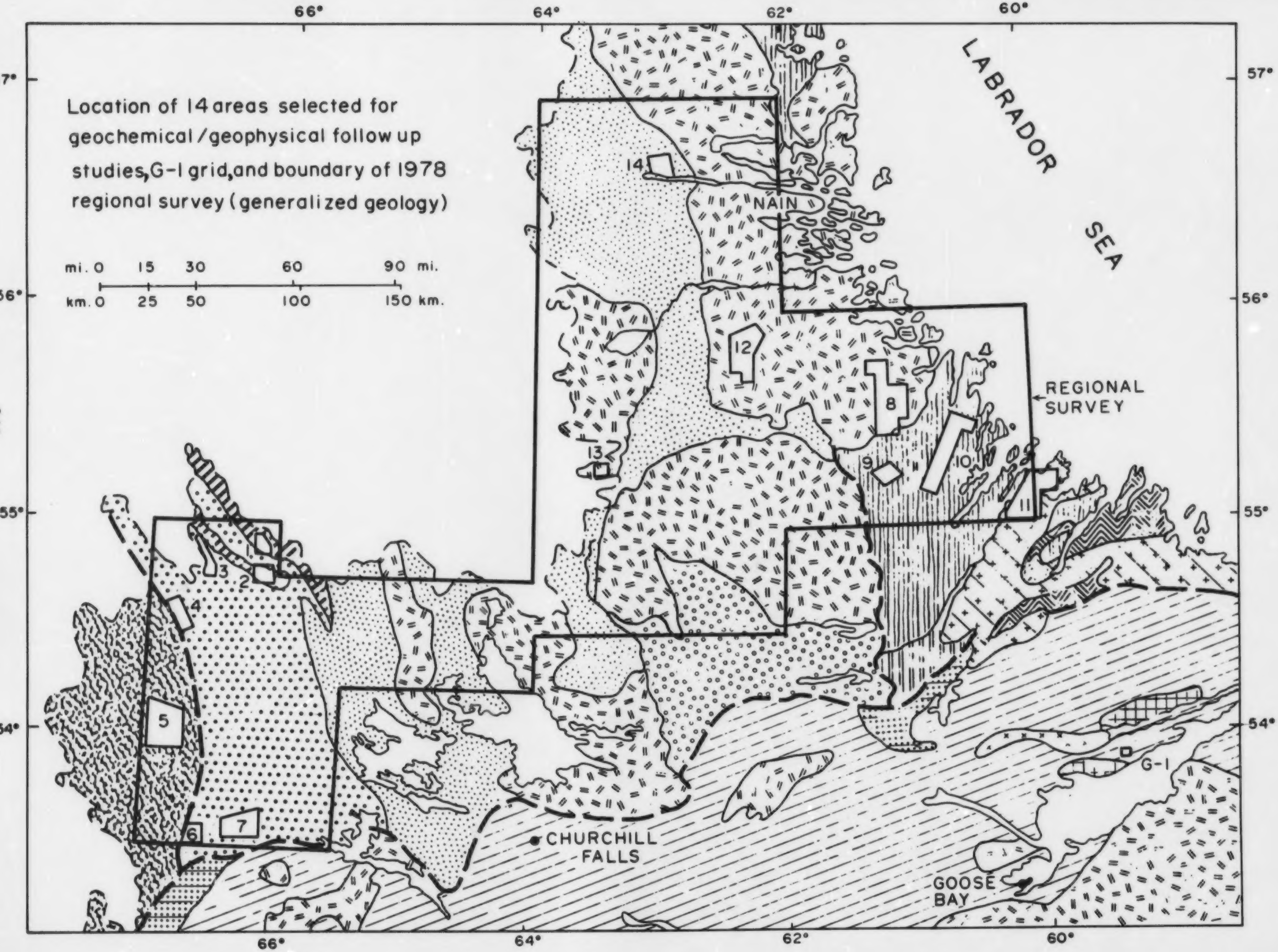
HELIKIAN AND APHEBIAN	▥	Supracrustal sedimentary and volcanic rocks of the Moran Lake and Bruce River Groups
APHEBIAN	▧	Metamorphosed sedimentary and volcanic rocks of the Aillik Group
ARCHEAN	▥	Basement gneisses

SUPERIOR PROVINCE

ARCHEAN	▩	Granulitic gneisses and felsic to mafic intrusives

INTRUSIVE ROCKS

HELIKIAN	▢	Anorthosites, gabbros and associated acidic intrusives and extrusives
HELIKIAN AND EARLIER	⊡	Massive to poorly foliated acidic intrusives
APHEBIAN	⊠	Acidic intrusives and associated metamorphic rocks
	▨	Gabbroic sills



Location of 14 areas selected for geochemical/geophysical follow up studies, G-1 grid, and boundary of 1978 regional survey (generalized geology)

LABRADOR
SEA
NAIN
REGIONAL SURVEY
CHURCHILL FALLS
GOOSE BAY
G-1
1
2
3
4
5
6
7
8
9
10
12
13
14
66°
64°
62°
60°
57°
56°
55°
54°
mi. 0 15 30 60 90 mi.
km. 0 25 50 100 150 km.

1979: Geochemical and geophysical prospecting over a uranium occurrence in the Grenville Province, central Labrador. Mineral Development Division, Newfoundland Department of Mines and Energy, Open file, Lab. 457.

EVALUATION OF LABRADORITE GEMSTONE POTENTIAL OF THE NAIN AREA, LABRADOR

by

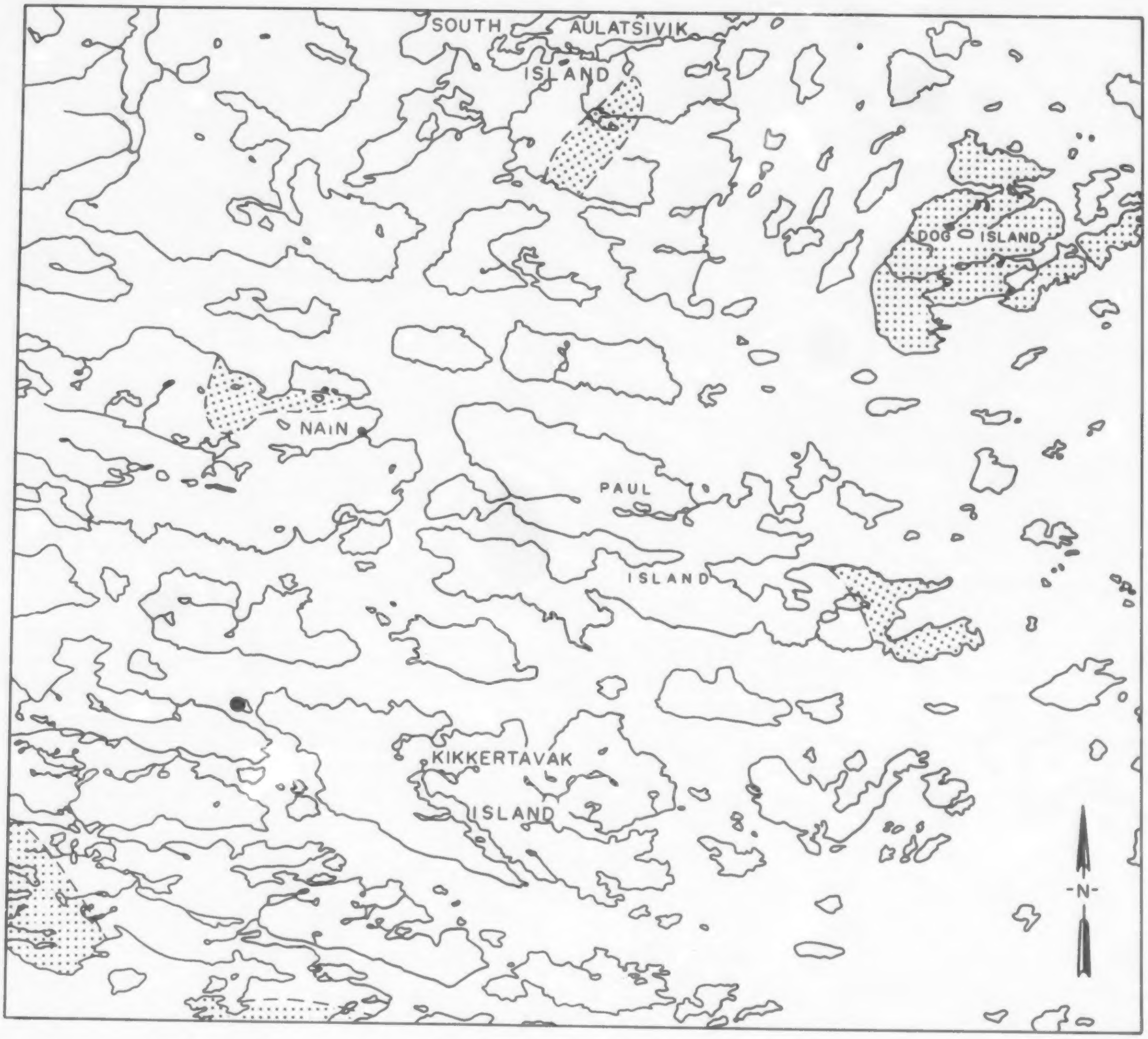
D. Watson

During the 1979 field season, the coastal area between Nain and Kamarsuk was examined for labradorite of gem grade.

The Nain area has been known as a source of labradorite since it was first discovered here in 1770 by a Moravian missionary. A quarry was opened on Tabor Island in 1953 by the International Grenfell Association and further work was done by Brinex in the period 1961-64. At present, a quarry permit is held by the Nain Crafts Council,which is removing small amounts for the local craftsmen.

During the summer, all of the shoreline of the mainland between Nain and Kamarsuk and of the islands offshore was examined for pegmatitic, chatoyant anorthosite. Numerous occurrences were discovered or reexamined having labradorite in crystals up to 50 cm in diameter and colors of blue, green, yellow, bronze, purple and red. In some of the locations, the quality is as good as or better than the material already mined from Tabor Island. In addition, the colors other than blue-green were discovered to be more abundant that previously recognized.

Based on the field work, it is concluded that there is an abundance of labradorite in the Nain area suitable for gem purposes; however, its true value will only be known after further tests to determine the cutting and polishing properties. In any case, there is enough good quality material available from the Grenfell Quarry (Tabor Island) to supply the needs of the local craftsmen for some time to come.

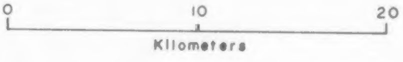

SOUTH AULATSIVIK ISLAND
DOG ISLAND
NAIN
PAUL ISLAND
KIKKERTAVAK ISLAND
N

Area Covered by Labradorite Gemstone Survey, 1979

● Grenfell Quarry (Tabor Island)

☐ Nain Anorthosite

▨ Non Anorthositic rocks (mainly adamellite)


0
10
20
Kilometers

DRILL CORE STORAGE PROGRAM

by

Gilbert McArthur and Cel Collins

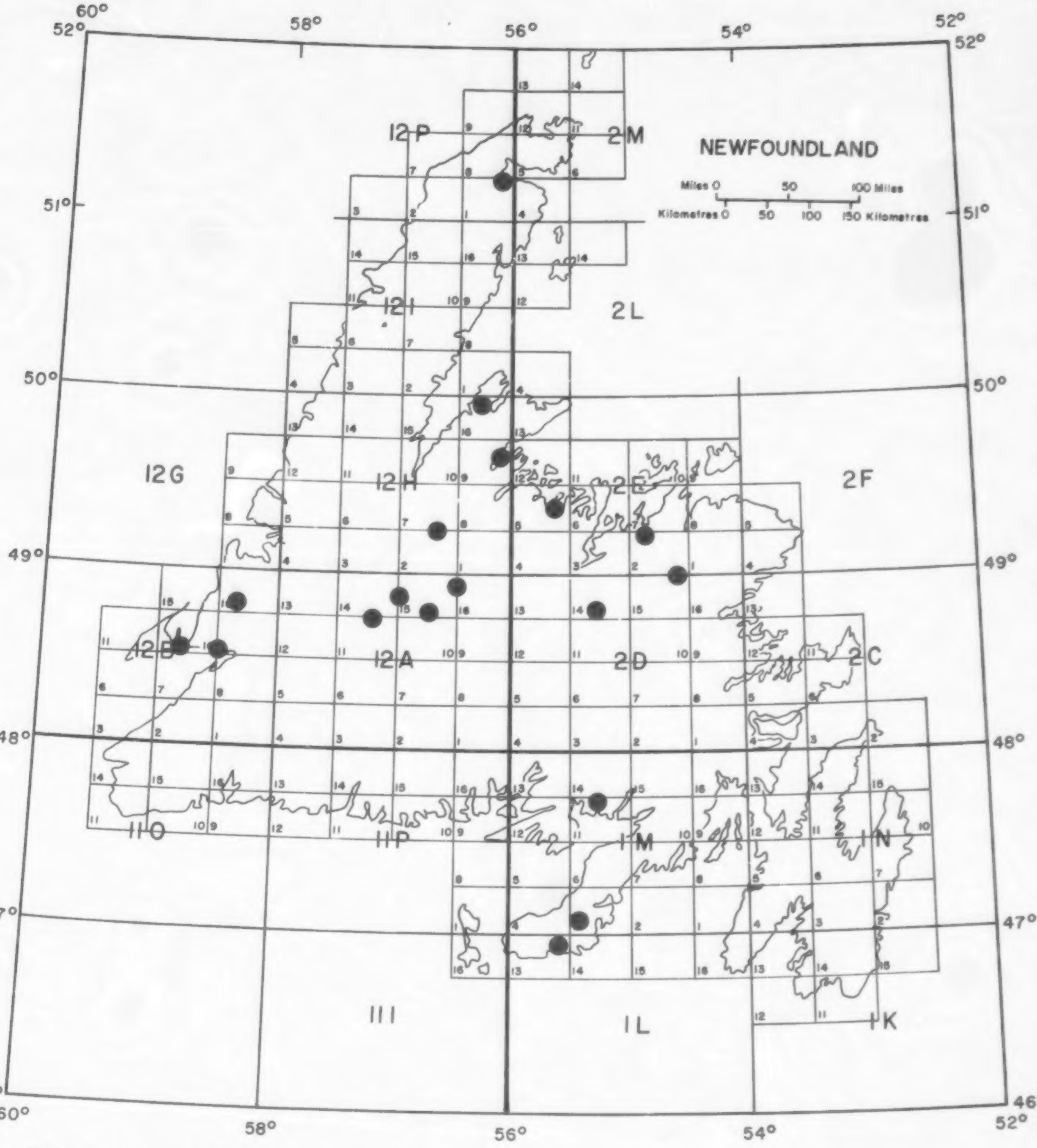
During 1979 a drill core library building was designed. It will be built by Beck Construction of St. John's starting in the fall, 1979. The building will be located at Torbay Airport and will have an approximate area of 450 square metres. It will have a storage capacity of approximately 60,000 metres of drill core as well as facilities for storage of representative rock collections from geological mapping programs and mineral deposit suites. The building will have a laboratory for examining core and equipment for splitting, cutting and polishing samples. There will also be microscopes and photographic equipment for detailed petrographic work. Geoscience files including drill logs, location plans, sections and indexes will be available for inspection.

These facilities will be available for use by exploration geologists, university researchers, the staff of the Department, and other interested persons.

In a separate part of the building, the Energy Branch will have limited space available for the storage of core and cuttings from wells drilled for hydrocarbon explorations.

During the 1979 field season, a program of core collection was started. With the cooperation of many exploration companies, abandoned core left in the bush over the years has been located and transported to temporary holding facilities in Pasadena, Springdale and St. John's.

Plans for 1980 include opening the Torbay library and a second similar facility being planned for Goose Bay, Labrador. Collection of abandoned core in Labrador will also be started.


NEWFOUNDLAND
Miles 0 50 100 Miles
Kilometres 0 50 100 150 Kilometres
60°
52°
58°
56°
54°
52°
52°
51°
51°
50°
50°
49°
49°
48°
48°
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47°
46°
46°
60°
58°
56°
54°
52°
12P
2M
12I
2L
12G
12H
2E
2F
12B
12A
2D
2C
11O
11P
1M
1N
11I
1L
1K

Figure 1: Location of Drill Programs where core recovered in 1979.

INVENTORY OF AGGREGATE RESOURCES

by

F. Kirby, R. Ricketts and D.G. Vanderveer

INTRODUCTION

The Inventory of Aggregate Resources in Newfoundland was begun in 1975 as part of the Surficial and Glacial Mapping Program and continued in 1976. In 1977 a separate sampling program conducted analyses in areas previously mapped surfically (Vanderveer, 1977; Grant, 1973; and Brookes, 1974). This program was supplemented in 1977 by sampling conducted by the Surficial and Glacial Mapping Program (Vanderveer and Sparkes, 1978).

The 1979 project has been a continuation of project 2.2 of The Inventory of Aggregate Resources program begun in 1978 and is funded under the Canada/Newfoundland Mineral Development Subsidiary Agreement. The program is designed to provide an inventory of aggregate (sand, gravel, crushed stone, stone, ballast) resources along existing and proposed transportation routes in Newfoundland and Labrador and will show the location, size, quality, present degree of use and potential of each deposit.

FIELD PROGRAM

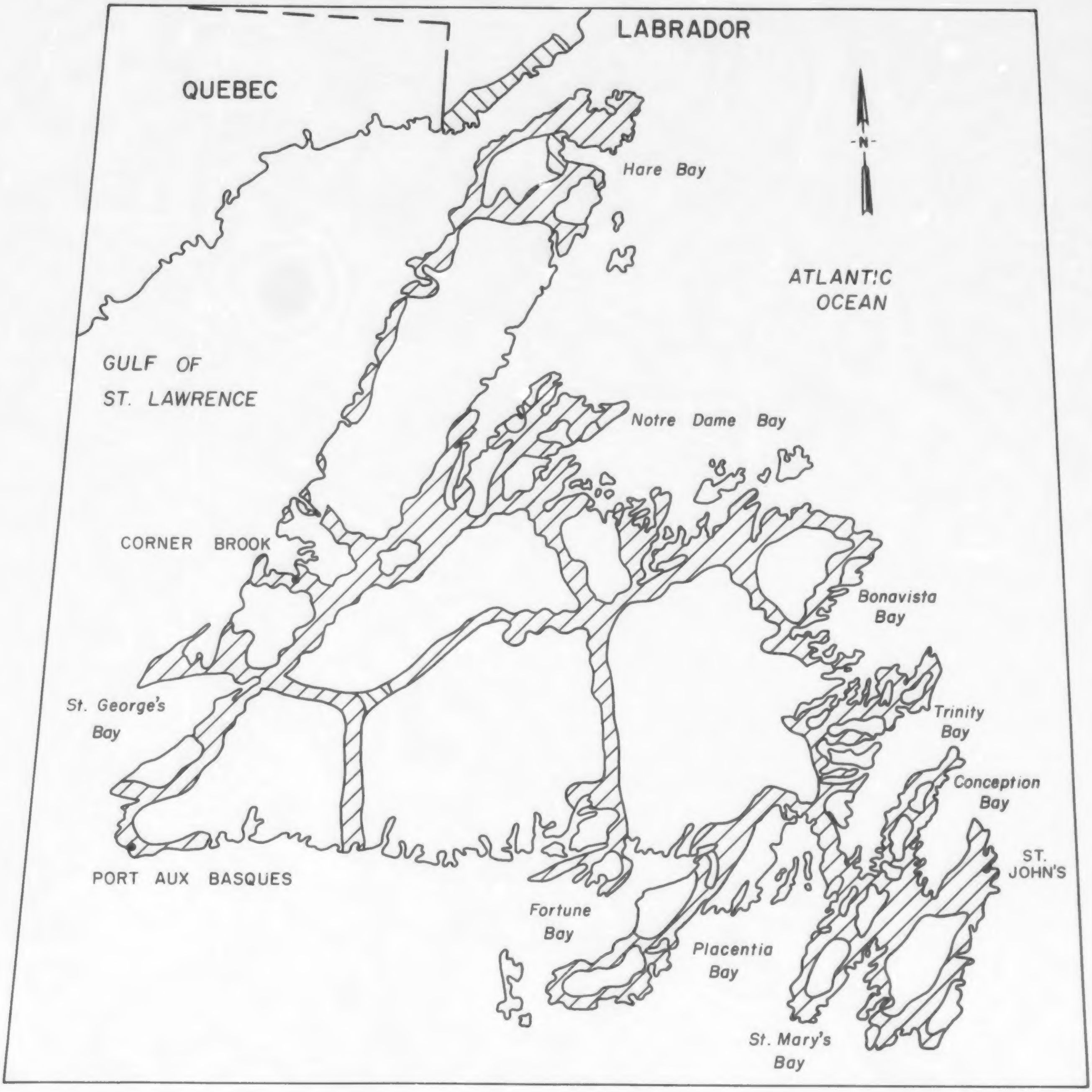
A 6 km wide corridor (Maps 1 & 2) centered and parallel to existing, proposed, or partially constructed highways and secondary roads in Newfoundland and Labrador is to be covered. Tertiary roads and trails capable of being ungraded to handle truck traffic were included in the corridor and sampling extended for a distance of 8 km along these from the main road.

Sampling was conducted mainly by vehicular traverses, but in areas of potential aggregate resources (*e.g.* glaciofluvial, fluvial, deltaic, marine or esker deposits) foot and canoe traverses were carried out. These traverses extended 3 km from the road with samples taken every 0.5 to 1 km in areas of aggregates. Additional samples were obtained where deposit changes occurred or quality differences were apparent at any given location; *i.e.*, where products could be quarried separately. In areas lacking potential sand and/or gravel material, morainal and bedrock materials were sampled; *i.e.*, one sample per 1 to 2 km, except where the varying nature of the deposit required additional sampling.

Generally, sample sites were limited to existing natural (stream or coastal cuts) or man made (road cuts, pits and quarry excavations, etc.) exposures. In areas of potential aggregate resources, shallow hand dug pits were made if no other exposures existed.

All field and sieve data for 1979 were placed on two separate forms. Form I gives general site information including data on location, landforms, stratigraphy, ice movement indicators, and notation for photo numbers and extra notes. Form II gives a field description of the sample, plus data on field sieve analyses, field pebble analyses and a section for laboratory sieve analyses.

Field sieve analyses were conducted on all samples containing +8 mm size material. Moisture tests were usually conducted on every second or third sample if the deposit remained consistent along the traverse route; otherwise, analyses were done at every sample location. During sieve analyses approximately 10 to 20 kg of material was sampled, weighed and sieved through


LABRADOR
QUEBEC
Hare Bay
N
ATLANTIC OCEAN
GULF OF ST. LAWRENCE
Notre Dame Bay
CORNER BROOK
Bonavista Bay
St. George's Bay
Trinity Bay
Conception Bay
ST. JOHN'S
PORT AUX BASQUES
Fortune Bay
Placentia Bay
St. Mary's Bay

MAP 1

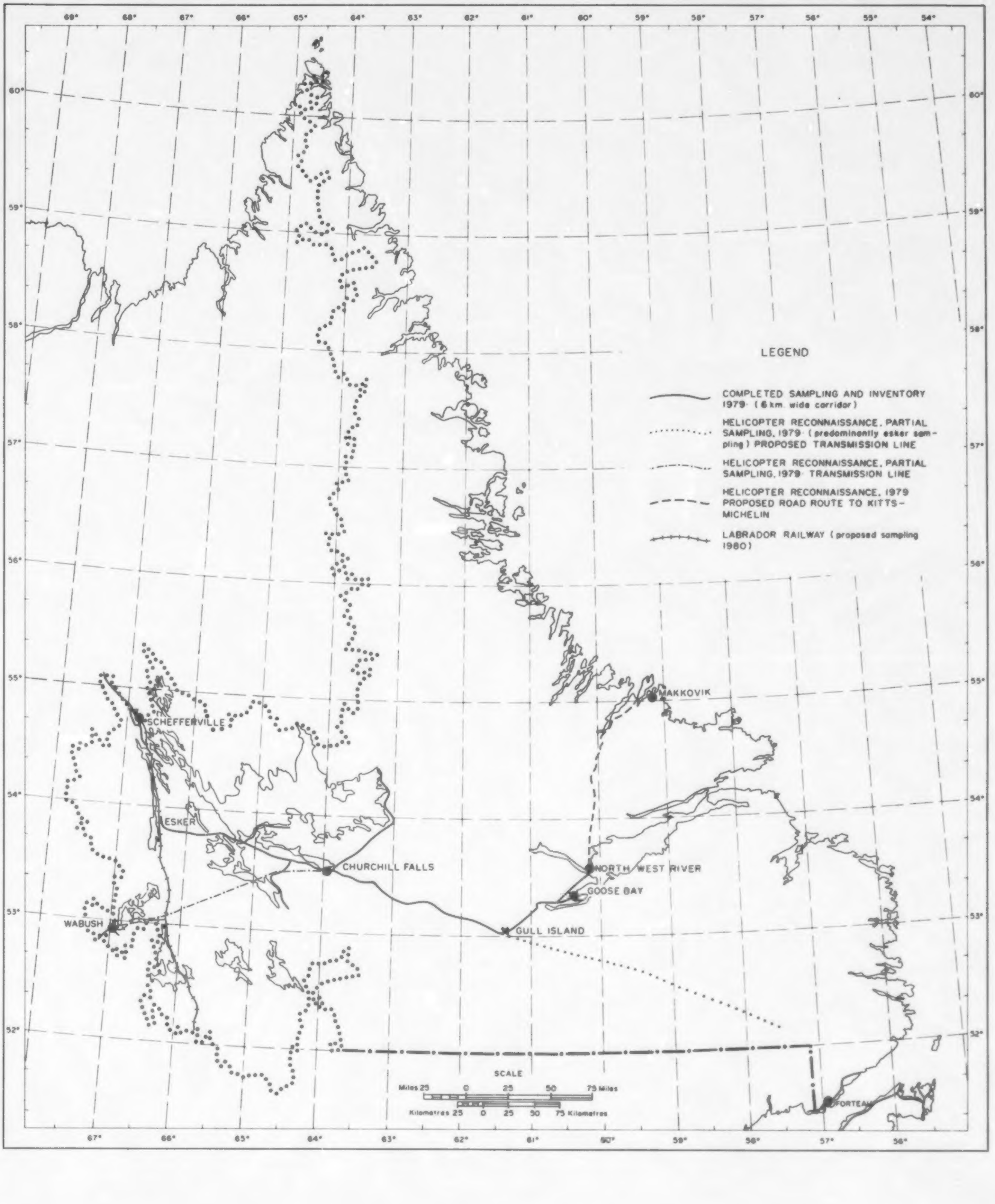
Inventory of Aggregate Resources Program
Island of Newfoundland
CANADA/NEWFOUNDLAND MINERAL DEVELOPMENT SUBSIDIARY AGREEMENT
SUBPROJECT 2.2

Legend

▨ completed 6 km wide corridor sampling parallel to existing roads and highways

▧ areas of incomplete survey at data of map compilation

☐ unsurveyed areas include Gros Morne and Terra Nova National Parks


LEGEND
COMPLETED SAMPLING AND INVENTORY 1979 (6 km. wide corridor)
HELICOPTER RECONNAISSANCE, PARTIAL SAMPLING, 1979 (predominantly esker sampling) PROPOSED TRANSMISSION LINE
HELICOPTER RECONNAISSANCE, PARTIAL SAMPLING, 1979 TRANSMISSION LINE
HELICOPTER RECONNAISSANCE, 1979 PROPOSED ROAD ROUTE TO KITTS-MICHELIN
LABRADOR RAILWAY (proposed sampling 1980)
SCHEFFERVILLE
ESKER
CHURCHILL FALLS
WABUSH
GULL ISLAND
NORTH WEST RIVER
GOOSE BAY
MAKKOVIK
FORTEAU
SCALE
Miles 25 0 25 50 75 Miles
Kilometres 25 0 25 50 75 Kilometres
69° 68° 67° 66° 65° 64° 63° 62° 61° 60° 59° 58° 57° 56° 55° 54°
60° 59° 58° 57° 56° 55° 54° 53° 52°
67° 66° 65° 64° 63° 62° 61° 60° 59° 58° 57° 56°

a bank of four, 30 cm diameter sieves (sizes 63 mm, 31.5 mm, 16 mm and 8 mm). The total sample weight and the weights retained on each field sieve and canvas were recorded on Form II. A 200-500 gm split of the -8 mm sand-silt/clay fraction was retained for laboratory sieve analyses. If a sample had a high silt-clay content and/or a high moisture content, it was wet sieved; *i.e.*, washed through the bank of sieves. The -8 mm size fraction for laboratory analyses was then taken from the exposure site. A split (100-200 pebbles) of the +16 mm retained pebble fraction of each sieved sample was saved for the field pebble lithological study. A bulk sample (500-1000 gm, minus any larger stones) was taken and returned to the laboratory for sieve analyses when sieve analyses were not conducted in the field. All samples were taken from fresh unweathered exposures and from below the normal soil horizon wherever possible. Where exposures permitted, channel sampling or multiple spot sampling was used to ensure a representative sample. More than one sample were collected from sites where different grades or types of material were encountered that might be exploited or excavated separately.

A reference collection of bedrock samples was compiled during the field traverses for each study area as an aid to the pebble lithology investigations. The pebble lithologic studies included information on the silt/clay coating, weathering, staining, sphericity, rounding, fracturing, mineralogy and texture for the various lithologies present in the pebble samples.

In addition to the above-mentioned sampling procedures, a more detailed experimental sampling project was carried out on a gravel deposit in the Butt's Pond area, about 25 km east of Gander. This project was designed to assess the feasibility of such projects in areas where the nature of the terrain or deposit characteristics would yield inadequate data if normal sampling procedures were used.

Samples for this project were taken at about 250 m intervals, to more accurately delineate horizontal and vertical depositional changes. A backhoe was used extensively in order to define the characteristics of the deposit. Depths reached with the backhoe were normally 2.7 to 3.2 m.

In addition to the road mapping, a series of helicopter reconnaissance progams were conducted in Labrador in July and August. The areas covered were: (a) proposed transmission line (Techmont Consultants Ltd.) route from Gull Island-Muskrat Falls to Forteau, (b) the Churchill Falls to Wabush transmission line route, (c) the proposed road route from North West River to Kitts-Michelin sites (Makkovik area). See Map 2. These areas were only partially sampled, the main objective being to provide logistical data for planning the routes and type of sampling program needed in 1980/81 for completion of Aggregate Resources Inventory in these regions.

LABORATORY PROGRAM

The laboratory program consists of sieve analyses of the sand-silt/clay fraction of each sample returned from the field. These analyses consisted of drying and splitting the sample to a manageable size (70 to 140 gm); then sieving through a bank of seven sieves (4 mm, 2 mm, 1 mm, 0.5 mm, 0.25 mm, 0.125 mm and 0.062 mm) for each sample of gravel or sand, i.e. samples not containing much silt and/or clay material. The weights retained on each sieve and in the pan were recorded on Form II.

Glacial tills and other samples of a high silt and/or clay content were treated as follows: 1) the sample was dried and split to 70 to 140 gm; 2) deflocculated using a few drops of a dilute solution of hydrogen peroxide (3 percent H_2O_2); 3) wet sieved through the 0.062 mm sieve; 4) the plus 0.062 mm sand fraction was dried and sieved, and the data recorded as with sand and gravel samples and; 5) the minus 0.062 mm fraction (water and silt and clay) was flocculated and settled by adding a small amount of magnesium chloride (1N $MgCl_2$), the excess water removed and the resultant silt-clay mixture dried, weighed and this data recorded on Form II also.

The sample and site number, N.T.S. map number, the percents gravel, sand, and silt-clay, and the moisture content were recorded and a particle size cumulative curve and a histogram will be plotted for each sample. All field and laboratory data will be stored on computer for ease of retrieval.

Pebble lithology studies conducted in 1979 consisted of a review of the geological literature of each study area, the selection of a reference collection of rock specimens for each study area, and the determination of the percentage of each rock type found in each sample of pebbles. A brief report will be written concerning this study for each area investigated.

RESULTS

During the 1979 field season 3039 samples were collected. The breakdown of these samples was as folows: tills - 884, gravels - 1058, sands - 745, silt - 46, clay - 68, rock - 236, and organics (including peat, shells and fossils) - 2.

The samples were collected from the following map areas: Eastern Newfoundland (1N/6 & 7, 2C/12-13, 2D/1, 2D/3-6, 2D/8-9, 2D/12-16, 2E/1-4, 2E/6-8, 2E/10-11, 2F/4-6, 11P/8-9); Western Newfoundland (110/11, 110/14-15, 11P/12-13, 12A/4-6, 12A/10-11, 12A/13, 12A/15-16, 12B/2-3, 12B/6-11, 12B/15-16, 12G/1, 12G/4, 12H/4); Labrador (13B/1, 13B/6-7, 13B/10-11, 13B/12, 13B/15, 13C/9, 13C/14-16, 13E/1, 13E/5-8, 13E/11-15, 13F/1-4, 13F/7-9, 23G/1-2, 23G/16, 23H/4-7, 23H/9-11, 23H/13-15).

Field pebble lithology studies were conducted on approximately 1660 pebble samples collected during 1979.

Sampling and sieve analyses in years previous to 1977 (Vanderveer, 1976, 1977) have contributed additional data on a number of areas, *i.e.*, Avalon Isthmus (1N/5, 1M/7, 1N/12-13, 1M/16, 2C/4), Wesleyville-Carmanville (2E/8, 2F/4-6) Deer Lake-Harry's River (12A/13, 12B/9, 12B/16, 12H/3) areas and the Forteau and Goose Bay areas, Labrador. Some of this data is available through open file releases 958 (Burin Peninsula), 959 (Southwest Newfoundland), 960 (Avalon Isthmus area) and the rest is available upon request.

Analyses of the 1977 data (Vanderveer and Kirby, 1978) has been completed and is available upon request. Areas covered in 1977 included: St. John's (1N/10), Holyrood (1N/6), Burin Peninsula (1L/13-14, 1M/3-4), southwest Newfoundland (12B/2, 12B/7-8, 110/10-11, 110/14-15), Stephenville-Port au Port (12B/6, 12B/10-11, 12B/15), Great Northern Peninsula (12H/5-6, 12H/12-13, 12I/4-6, 12I/11, 12I/14), and Southern Labrador (12P/6-7, 12P/9-11).

Analyses of the 1978 field data (Vanderveer, et. al., 1979) has been completed and is available upon request. The areas covered in 1978 included: Southern Avalon Peninsula (1N/2-4, 1K/11-15), Harbour Grace-Bay de Verde (1N/11, 1N/14, 2C/2-3), Isthmus of Avalon (1N/5, 1N/12-13, 1M/16, 2C/4), Burin Peninsula (1L/13-14, 1M/3-4, 1M/6-7, 1M/10, 1M/16), Bonavista Peninsula (2C/5-6, 2C/11-12), Grand Falls to Deer Lake area (2D/13, 2E/5, 2E/12-13, 12A/9-10, 12A/15-16, 12G/8, 12H/1-12, 12H/15, 12H/16), Great Northern Peninsula (2L/13, 2M/5, 2M/11-12, 12H/13, 12I/4-6, 12I/9, 12I/11, 12I/14-16, 12P/1-3, 12P/7-9). All data collected in 1978 will be incorporated into the 1979 data file.

INDEX OF NEWFOUNDLAND 1:50,000* SURFICIAL MAPPING

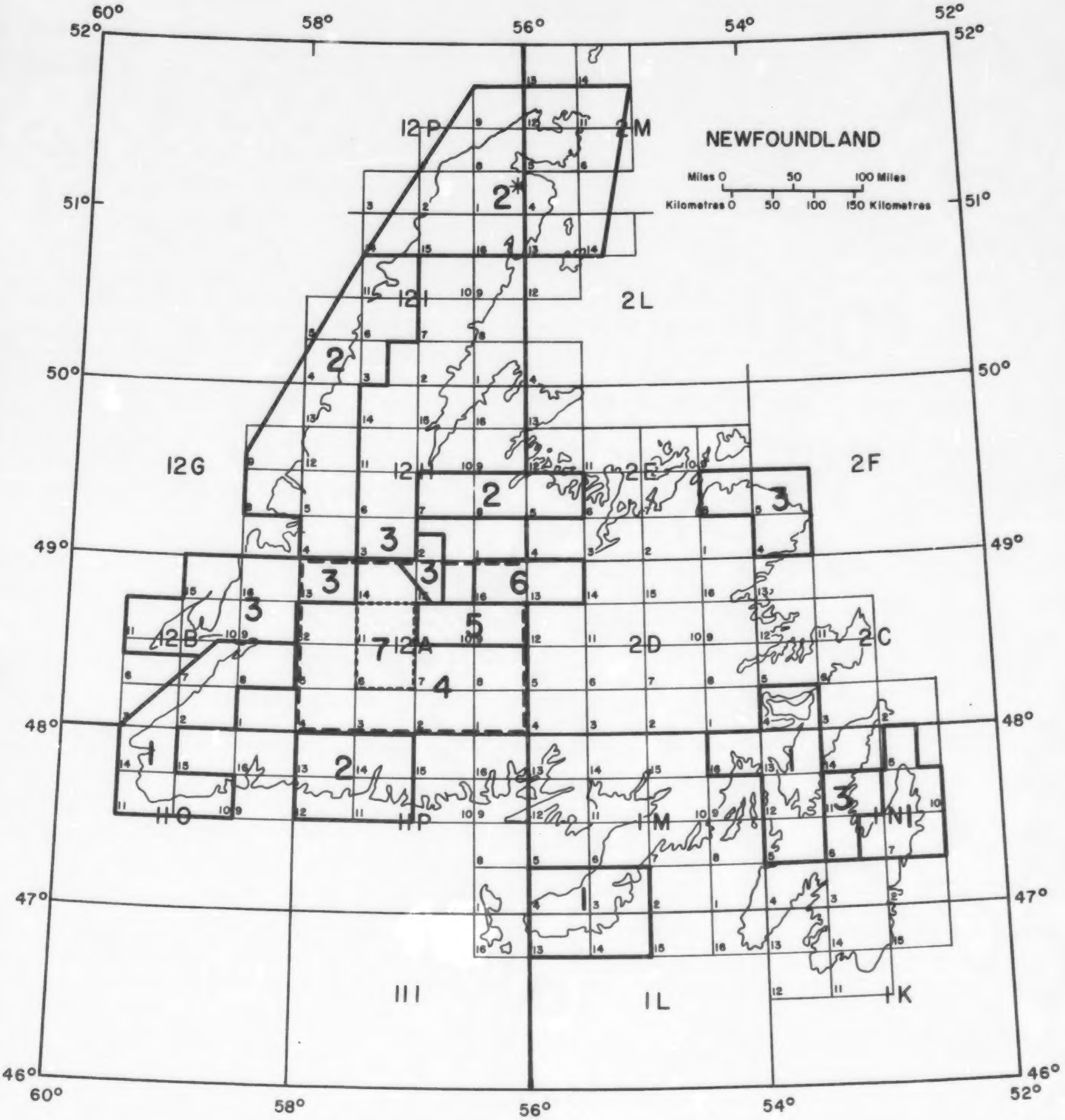
Open File releases:

1. Newfoundland Department of Mines and Energy
2. Geological Survey of Canada +

In preparation:

3. Newfoundland Department of Mines and Energy - Preliminary copies available upon request**
4. Geological Survey of Canada; D. R. Grant - Maps of 12A; Preliminary copies available upon request***
5. Newfoundland Department of Mines and Energy - 1978 maps preparation++
6. Newfoundland Department of Mines and Energy - 1979 maps in preparation++
7. Proposed mapping in 1980/81

*Scale of St. Anthony - Blanc Sablon Area, 1:100,000
+Available from Publications and Information Section, Newfoundland, Department of Mines and Energy
**Available from Environmental Geology Section (D. G. Vanderveer), Newfoundland Department of Mines and Energy
***Some preliminary maps are on file with the Environmental Geology Section (D. G. Vanderveer)
++For status, contact Environmental Geology Section (D. G. Vanderveer)


NEWFOUNDLAND
Miles 0 50 100 Miles
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46°
12P
2M
2*
12I
2L
2
12G
12H
2E
2F
3
6
5
12B
7
12A
4
2D
2C
1
11O
11P
1M
1N
11I
1L
1K

Data from the 1979 program will be released as it becomes available. An outline of potential areas of aggregate materials and the locations of all samples will be plotted on 1:250,000 topographic base maps for open file release. These data will also be recorded on 1:50,000 base maps for release upon request.

When the laboratory analyses program is completed on the samples collected during 1979, data will be available for 7308 samples collected since 1975, and covering most of Insular Newfoundland, and the road system of Labrador.

ACKNOWLEDGEMENTS

The authors wish to thank Derek Newman, Martin Ricketts, and Ed Blackwood (senior field assistants), Dan Bragg, Doug McNulty (field lithogical investigators), Richard St. Croix, Dave Maloney, Glenn Power, Carl Butt, Ben Warren, Jeff Ryder, Calvin Blackmore (junior field assistants), and Beverly Thompson and Beverly Wareham (laboratory technicians).

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BADGER-GRAND FALLS AREA SURFICIAL AND GLACIAL MAPPING

by

B.G. Sparkes and D.G. Vanderveer

INTRODUCTION

During 1979 a project was funded to conduct a detailed surficial and glacial interpretation in the Badger 12A/16 and Grand Falls 2D/13 map areas of central Newfoundland, (MAP 1). This project is a continuation of the Surficial and Glacial Mapping program in the Central Mobile Belt designed to provide information as an aid to mineral exploration. This area was chosen because of its recognized mineral potential, recent exploration activity, its scattered occurrences of mineralized float, and its thick and extensive cover of overburden which has given rise to difficulties in geological mapping. Most of the current map area has good access, a considerable number of till exposures and unweathered bedrock exposures exhibiting striations and other glacial flow indicators.

FIELD PROGRAM

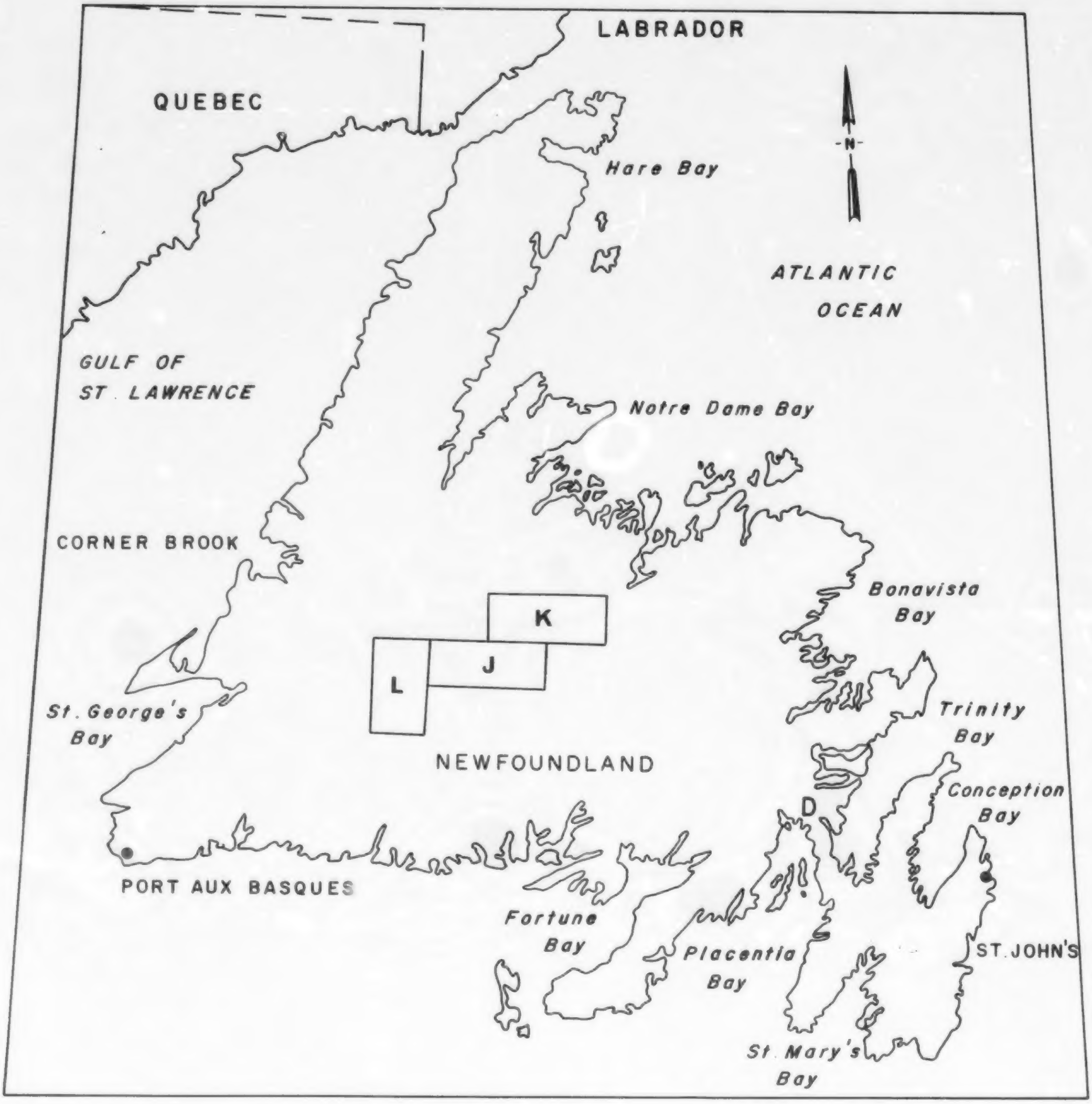
Mapping started in mid-May and continued until early October. Information was obtained along all existing roads and most lake shorelines and streams. Eighteen hand-dug, and seventeen backhoe-dug pits provided suitable exposures for till fabrics and samples at 1 metre intervals. Of the thirty-five pits which were dug, fabrics were done in thirty, the remainder were either too unstable to work in because of slumping due to ground-water flow or lacked enough stones to identify a fabric. During the course of field work 900 sites were noted and 130 sets of striae recorded with directions and/or relative ages assigned to 115 of these. Of the 475 samples taken, 400 were till, and the remainder either sand, gravel or rock. At 125 of the 325 till sites, a representative pebble fraction was obtained and a determination of the pebble lithologies was made. This study also included information on the silt/clay coating, weathering, staining, sphericity, rounding, fracturing, mineralogy and texture for the various lithologies present.

GLACIAL STRIAE

Throughout the area one major set of striae at 050-075 has been recorded with the dominant direction being approximately 060. On numerous outcrops, a second striae direction usually perpendicular or sub-perpendicular to the dominant set was recorded. In all cases where directions have been assigned to striae, one or more of the following indicators have been used: (a) miniature crag and tail (b) crescentic or lunate fractures or gouges, (c) nail head striae, and (d) minature stoss and lee forms.

GLACIAL INTERPRETATION

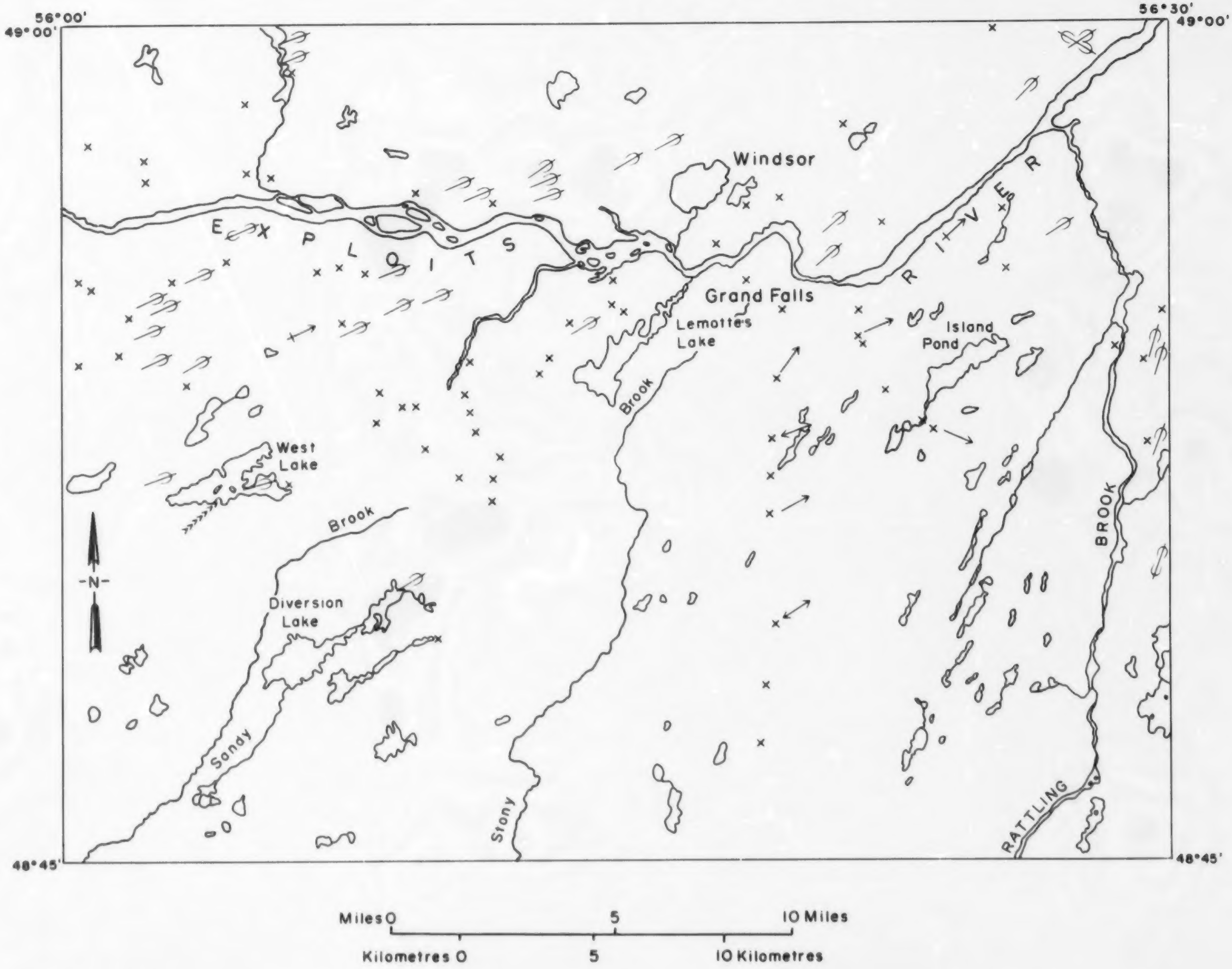
The glacial history of the area, based on the striae and till fabrics compiled to date, has indicated only the generally northeast movement (Maps 2, 3) of what has been concluded to be mid to late stage Wisconsin ice (Vanderveer and Sparkes 1979). This movement parallels the regional structure in most areas but may run sub-parallel to local topography. In the few areas where striae have been found in other directions, these have been interpretated as being younger than the northeast movement and formed as a result of late topographically controlled flow of ice from the ridges into the valleys during the waning stages of glaciation.


LABRADOR
QUEBEC
Hare Bay
N
ATLANTIC OCEAN
GULF OF ST. LAWRENCE
Notre Dame Bay
CORNER BROOK
Bonavista Bay
K
J
L
St. George's Bay
Trinity Bay
NEWFOUNDLAND
Conception Bay
D
PORT AUX BASQUES
Fortune Bay
Placentia Bay
ST. JOHN'S
St. Mary's Bay

Map 1

J. Lake Ambrose - Noel Paul's	(1978)	O.F. 12A (212)
K. Badger - Grand Falls	(1979)	
L. Proposed Mapping	(1980)	

GLACIAL FLOW FEATURES – GRAND FALLS 2D/13


56°00'
49°00'
56°30'
49°00'
48°45'
48°45'
EXPLOITS
RIVER
Windsor
Grand Falls
Lemottes Lake
Island Pond
West Lake
Brook
Diversion Lake
Sandy
Stony
Brook
BROOK
RATTLING
-N-
Miles 0
5
10 Miles
Kilometres 0
5
10 Kilometres

SYMBOLS

Glacial striae (direction of ice movement known, unknown. Number indicates relative age, 1 being the oldest

Till fabrics (ice flow direction known, unknown).

Esker (direction of flow known, unknown)

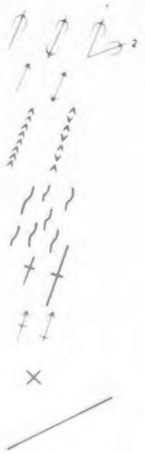
Minor moraines, rib moraines, washboard moraines, annual moraines, till ridges transverse to ice flow (irregular, straight)

Drumlins and drumlinoid ridges

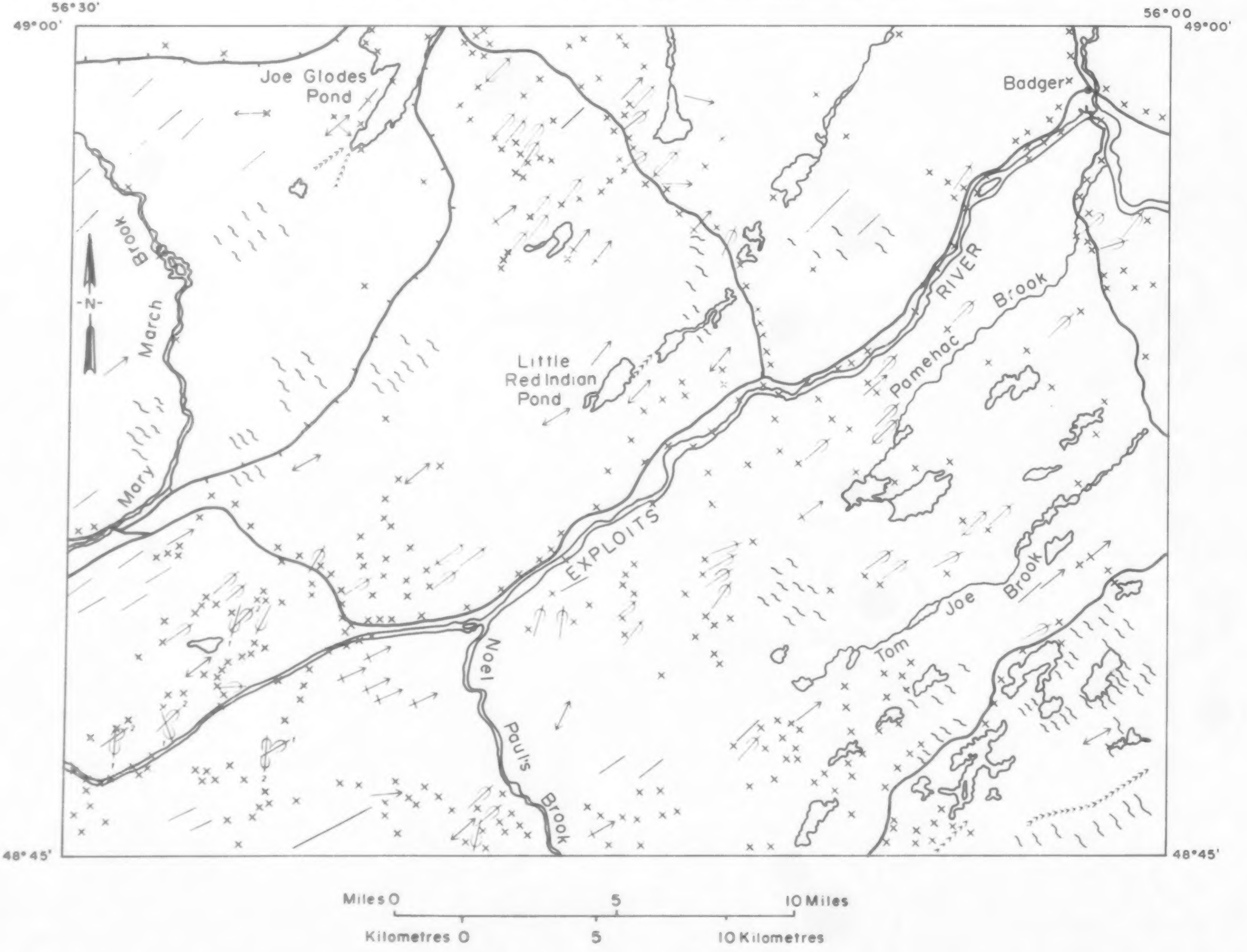
Crag and tail hills and ramps

Sample sites

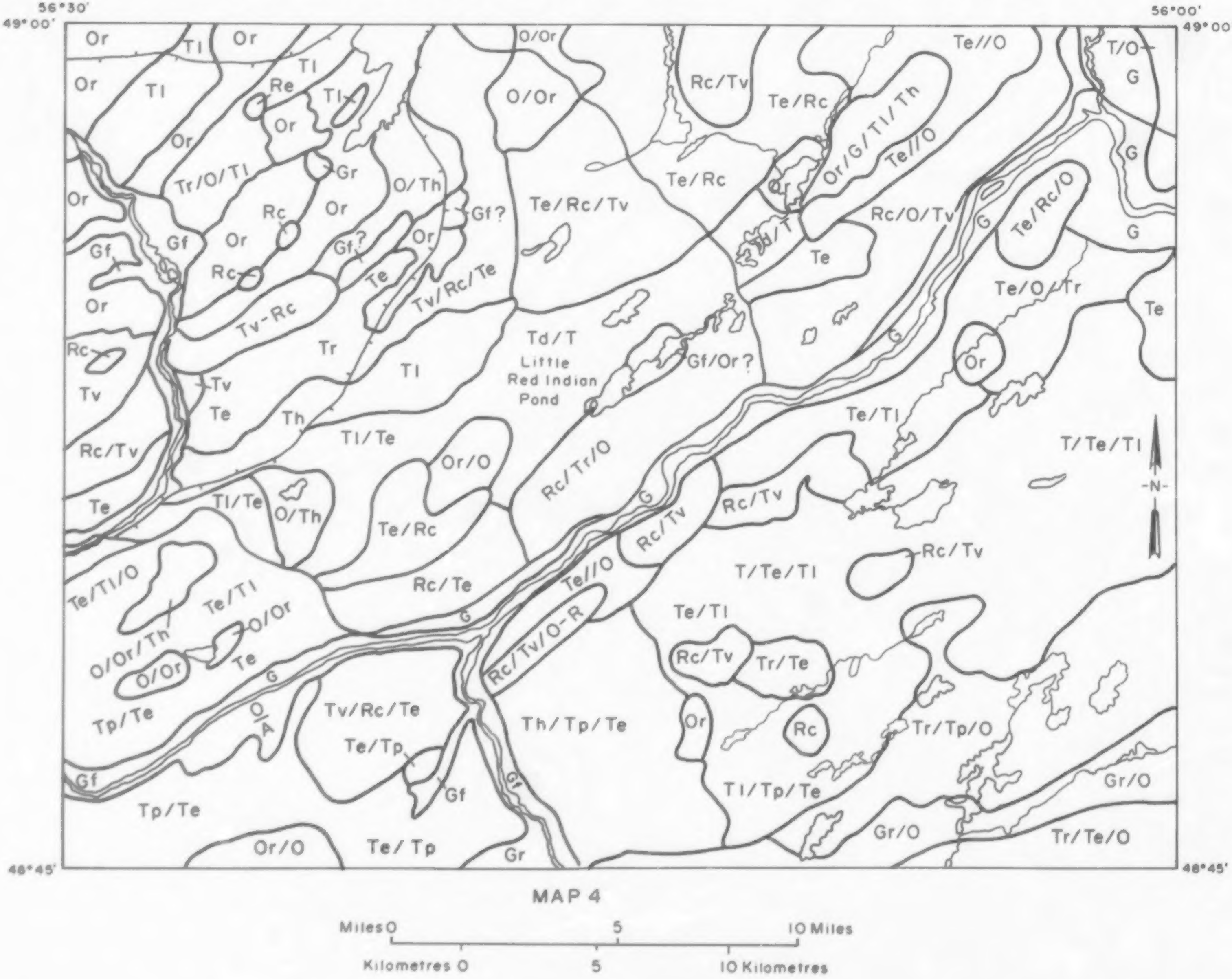
Glacial linear feature



GLACIAL FLOW FEATURES - BADGER 12A/16


56°30'
49°00'
56°00
49°00'
48°45'
48°45'
Joe Glodes Pond
Badger
Little Red Indian Pond
EXPLOITS RIVER
Pamehac Brook
Tom Joe Brook
Noel Paul's Brook
Mary March Brook
N
Miles 0
5
10 Miles
Kilometres 0
5
10 Kilometres

GENERALIZED LANDFORM CLASSIFICATION BADGER 12A/16


56°30'
49°00'
56°00'
49°00'
48°45'
48°45'
Or
Tl
Or
Tl
Re
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Or
Or
Tr/O/Tl
Gr
Rc
Or
Or
Rc
Gf
Gf
Or
Rc
Tv-Rc
Tv
Tv
Te
Rc/Tv
Te
Tr
Th
Tl
Te
O/Th
Gf?
Or
Gf?
Tv/Rc/Te
O/Or
O/Or
Te/Rc/Tv
Td/T
Little
Red Indian
Pond
Gf/Or?
Tl/Te
Or/O
Tl/Te
O/Th
Te/Rc
Rc/Tr/O
Rc/Te
Te/Tl/O
Te/Tl
O/Or
O/Or/Th
O/Or
Te
G
Tp/Te
O
A
Gf
Tp/Te
Tv/Rc/Te
Te/Tp
Gf
Gf
Or/O
Te/Tp
Gr
Rc/Tv
Te/Rc
Te/Rc
Or
Td/T
Or/G/Tl/Th
Te//O
Te//O
Rc/O/Tv
Te
G
Te/Rc/O
G
T/O
G
G
G
Te/O/Tr
Te
Or
Te/Tl
T/Te/Tl
-N-
Rc/Tv
Rc/Tv
G
Te//O
Rc/Tv/O-R
Rc/Tv
T/Te/Tl
Te/Tl
Rc/Tv
Tr/Te
Or
Rc
Th/Tp/Te
Tr/Tp/O
Tl/Tp/Te
Gr/O
Gr/O
Tr/Te/O
Miles 0
5
10 Miles
Kilometres 0
5
10 Kilometres

MAP 4

SURFICIAL LANDFORM CLASSIFICATION

Morphological Modifier:	Genetic Category:	Morainal	Glaciofluvial	Alluvial	Marine	Lacustrine	Eolian	Colluvial	Organic	Rock
		T	G	A	M	L	E	C	O	R
drumlinoid	(d)	Td								
plain	(p)	Tp	Gp	Ap	Mp	Lp			Op	
hummocky	(h)	Th	Gh							
ridged	(r)	Tr	Gr		Mr	Lr	Er		Or	Rr
veneer	(v)	Tv	Gv	Av	Mv	Lv	Ev	Cv		
terraced	(t)		Gt		Mt	Lt				Rt
eroded and dissected	(e)	Te	Ge		Me	Le		Ce		
kettled	(k)	Tk	Gk							Rk
deltaic	(f)		Gf	Af				Cf		
lineated	(l)	Tl					El		Ol	Rl
concealed by vegetation	(c)							Cc		Rc
weathered	(w)						Ew			Rw
ridged complex	(rx)		Grx							

TABLE 1

1979

SURFICIAL CLASSIFICATION

The geomorphological classification is based on a landform system (Table 1) which consists of a combination of one or more landforms. Each landform is designated by a genetic category and a morphological modifier. The genetic category denotes the type of deposit and the morphological modifer describes the possible mode of formation of each deposit. A generalized landform map (Map 4) has been compiled for the Badger area.

FUTURE PLANS

Plans include: (a) preparation of pebble lithology data, (b) analyses of the till fabric data (c) textural analyses of till samples, (d) compilation of airphoto interpretation of surficial landforms and field data, to produce a surficial map (scale 1:50,000) and (e) geochemical analyses of till samples and selected analyses for heavy mineral assemblages. An open file release should be made in early 1980.

Surficial and glacial mapping in the Buchans to Annieopsquotch Mountains area is planned for the coming field season.

ACKNOWLEDGEMENTS

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